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THE SURGICAL IMPORTANCE OF "BROWN FAT"

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An investigation into our knowledge of the mode of formation of fat tissue, its alterations and reactions in disease reveals many hiatuses.

From the time of the application of microscopy to the study of tissues, there have been two views of the origin of fat: (1) that the fat cells develop from special cells the function of which is to develop and store fat, and (2) that the fat is stored by cells which are constituents of, and ubiquitous in, the connective tissues.

Around this question, a constant dispute has been waged and evidence in support of both views has been submitted.

Todd and Bowman, Toldt, Ranvier, Bobritzky, and Klein supported the view concerning special fat cells, while Kolliker, Czajewicz, Flemming, and the Hoggans considered that they arose by a modification of connective tissue cells. The question is still undecided, but the evidence is in favor of the former view.

Toward the end of the last century, Ehrmann, Paljakoff, and Metzner described large spheroidal cells containing small globules of fat instead of the single large globule. These cells had been named by Ludwig, "mulberry cells."

In 1902, Batty Shaw reviewed the position and examined material obtained from the human fetus and newborn. He found that the fat in the subcutaneous tissue of the human embryo occurred in cells containing a single globule. On the other hand, the fat in the axilla and beneath the pleura did not contain the signet ring cells of ordinary fat, but possessed cells showing abundant protoplasm containing small fat droplets and a central nucleus.[1]

In the same year, Hatai described, in human embryos, the presence of an interscapular gland corresponding to the so-called hibernating gland of the lower animals. This consisted of a narrow paired organ lying in the neck and extending into the scapular region. This hibernating gland in the hedgehog had been well described in 1893 by Carlier.

It thus appeared that in the human being there were two forms of fat; the ordinary yellow fat and another variety which was present only in the fetus and young children.

In 1908, however, Bonnot investigated the question very thoroughly and found that this less common tissue extended over a much larger area than that stated by Hatai. He also found that it did not disappear entirely after childhood, but could be found in the adult. Resulting from this description, the tissue is sometimes called the gland of Bonnot. It is well developed in the newborn and in adults it is a lobulated structure, pinkish in color and, on section, having the appearance of gland tissue. In the cadaver the color is

[1]He considered, however, that this was merely a stage in the formation of ordinary fat.

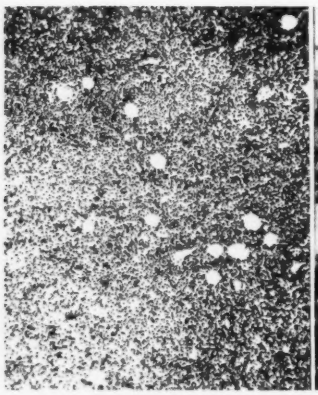
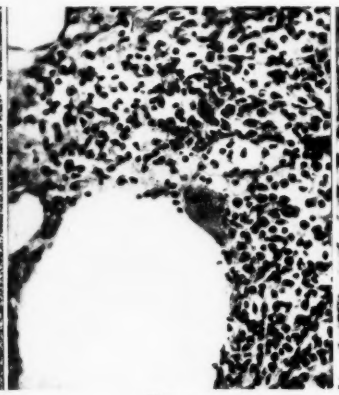


Fig. 1.



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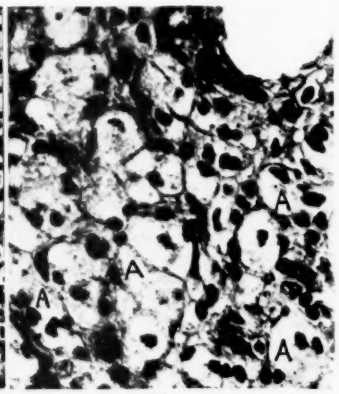


Fig. 3.

Fig. 1. Photomicrograph of a section showing the type of tissue found in the specimen removed in Case. 1. There are a large number of moruloid fat cells and a very few fat spaces. ×35.

Fig. 2. Higher power view of the tissue shown in Figure 1. A giant cell is present near the fat space, but the typical cells are those comprising the remainder of the section ×135.

Fig. 3. High power showing the characters of the cell shown in Figures 1 and 2. The cells have central nuclei and in the protoplasm there are numerous fat droplets ×600.

dark brown. Its distribution is irregular and it may be found in the neck, axilla, breast, and in the subpleural and perirenal tissues.

Bonnot concluded that the "gland" was constant in mammals, corresponded to the hibernating gland of the rodents, and that its probable functions were the storage of fat, as a scavenger of fat and as a blood forming organ. The evidence for the last suggestions is given in his paper. Suffice it to say that the size of the gland varies with the state of nourishment of the individual, that the gland differentiates, during development, into hæmolymph glands which are known to produce blood corpuscles and that the cells of the gland, at times, are observed to contain blood pigment.

This fat tissue has been designated brown fat from its color, mulberry or moruloid fat from its microscopic appearance; and the interscapular gland, from its position in animals.

In 1909, Shattock read a paper before the pathological section of the Royal Society of Medicine on "Normal Tumour-like Formation of Fat." He reaffirmed the distinction between the two types of fat and showed that the fatty masses occurring in the necks of cretins were composed of brown fat.

In 1927, Inglis described tumors arising in the brown fat or "interscapular gland" of the neck of infants, and he mentioned one other case recorded previously.

Apart from these descriptions of pathological changes in brown fat, the possibility that disease of this structure might give rise to disturbances of surgical importance has been overlooked.

Having encountered, in various parts of the body, nodules which microscopically present the appearances of brown fat, and particularly since similar lesions have not been recognized —or at least, not reported in the literature — 3 cases are described and discussed.

CASE HISTORIES

Case 1. B. M., male, aged 40 years, proprietor of a knitting factory. He complained of a lump in the right groin of at least 3 months' duration. He thought it came on suddenly. It was tender on palpation, and movement of the right leg caused pain. There was no pain while he rested. There had been no gastro-intestinal disturbance and he had not lost weight. He had had an operation for a right inguinal hernia, 2 years previous to the present illness.

Examination disclosed a hard, irregular mass in the right iliac fossa. It appeared to be under the skin and had indefinite edges. It could also be felt on the right side of the pelvis on rectal examination. A clysma revealed a normal colon. A piece of tissue

Fig. 4.

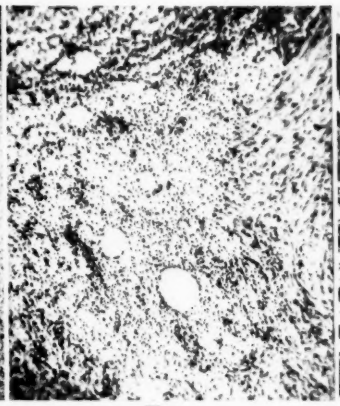


Fig. 5.

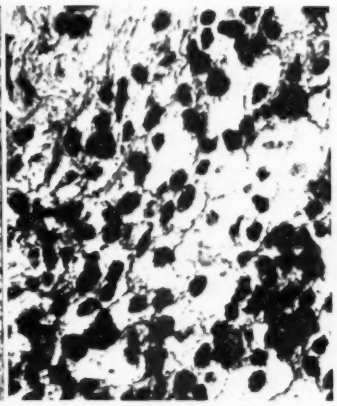


Fig. 6.

Fig. 4. Photomicrograph of a section of the tissue removed from Case 2. The moruloid cells in alveolar formation are seen. ×40.

Fig. 5. Another view of the same tissue as is shown in Figure 4. ×75.

Fig. 6. High power view of the cells of the tissue shown in Figure 4. The resemblance of this tissue to that shown in Figure 3 and also to the inflamed brown fat removed from the guinea pig (Fig. 16) will be seen. ×670.

was removed for microscopic examination. The tissue was very hard and grayish-white in color.

The evening temperature was raised (99 to 100 degrees) for about a month, when it subsided. The mass also disappeared. Several months later patient appeared to be quite well, with no mass or abnormality of the right iliac fossa.

Pathological examination. The tissue was an irregular piece measuring ½ inch in diameter. It was grayish-brown in color and extremely hard. Microscopically it consisted of collections of cells containing a considerable amount of protoplasm in which there were numerous fat droplets. The nuclei were centrally situated. These cells were arranged in fairly definite alveoli, some larger than others. Between the cells there were small round cells, fibroblasts, endothelial cells, and a few giant cells (Fig. 2). At the periphery of the nodule there was ordinary fat tissue which was inflamed, but the transition from this tissue to that of the nodule was abrupt. Under high power, the cells were seen to contain globules of varying size (Fig. 3), the majority small but some almost filling the cell and pushing the nucleus, which is in most cases placed centrally, to the periphery.

Case 2. Mrs. L., aged 38 years, complained of a tender lump in the lower portion of the abdomen of 3 weeks' duration. She was supposed to have spat up a hydatid of the lung years before, but otherwise her past history was negative. Three weeks before coming for treatment, she noticed a soreness in the lower part of the abdomen. A week later she noticed a lump and this gradually became more sore.

Examination disclosed a tender rounded mass deep in the abdominal wall about 2 inches in diameter and extending to about 2 inches from the pubes. It was decided to investigate the condition.

At operation, a mass about 1½ inches in diameter, arising from the extraperitoneal fat, was removed. The patient made an uninterrupted recovery.

Pathological examination. Macroscopically, the tissue was irregularly rounded in shape, brownish-yellow in color (after having been in formalin), and of moderately hard consistence. Microscopically, it consisted of small lobules of tissue some of which were almost identical with the lobules of fat in brown fat. The cells contained centrally situated nuclei and the protoplasm was filled with numerous small globules of fat. There were a few typical fat spaces. This appearance was found at only one portion of the tissue. In most sections the same underlying arrangement of tissues could be seen, but both the alveoli of the "moruloid" fat cells and the intervening fibrous connective tissue were infiltrated with the cells of inflammation—small round cells, endothelial cells, fibroblasts, etc. (Figs. 4, 5, 6.)

Case 3. A. L., female, aged 18 years. The patient had been suffering from a pyrexia of unknown origin for 7 weeks, undergoing medical treatment. She then developed a nodule in her left supraclavicular region. The writer saw the patient for the investigation of this condition. The nodule was removed in the hope that it might throw some light on the general condition. Subsequently the patient recovered without a diagnosis having been arrived at.

Pathological examination. The portion of tissue was ½ inch by ¼ inch in diameter and partly dark yellow and partly reddish in color. It was gland-like in consistence. Microscopically, the tissue consisted of lobules of "moruloid" cells in a connective tissue stroma. The cells showed the characteristic appearances. In one portion of the section, corresponding to the reddish area seen macroscopically, the structure was that of a hæmolymph gland.

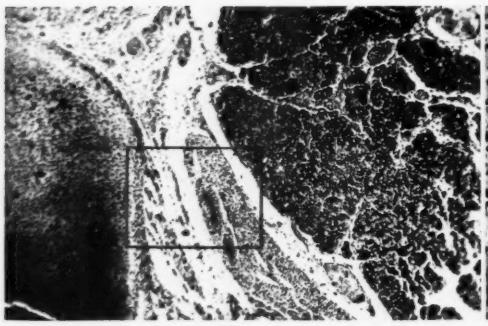


Fig. 7.

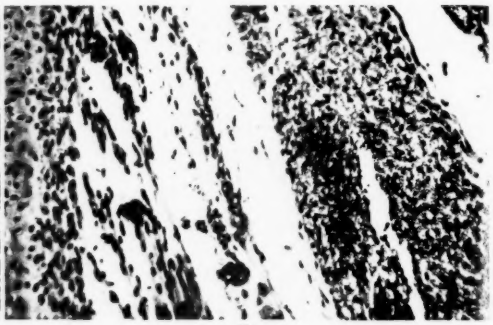


Fig. 8.

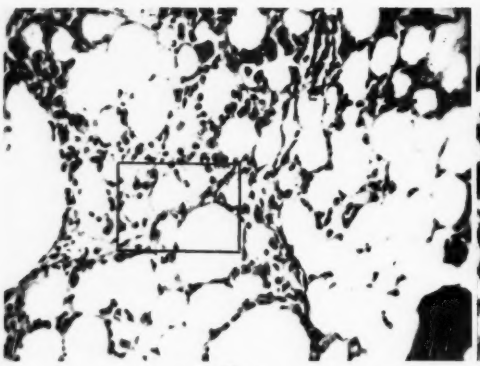


Fig. 9.

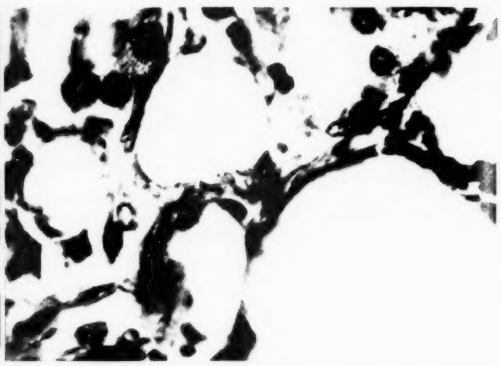


Fig. 10.

Fig. 7. Photomicrograph of a section taken from the neck of a fetus, 120 millimeters crown rump length. The rectangle shows the area of Figure 8. ×35.

Fig. 8. Photomicrograph of the area shown in Figure 7. ×145.

Fig. 9. Photomicrograph of a section taken from the fat removed from a guinea pig, 10 days after traumatization. The rectangle indicates the area of Figure 10. ×140.

Fig. 10. Section showing phagocytic cells between fat spaces. ×635.

Other examples, observed by the writer, which possess special features will be described elsewhere.

The suggestion that some of the less typical portions of the lesions were examples also of inflammation in brown fat led the writer to investigate the result of inflammatory changes in this tissue in lower animals.

EXPERIMENTAL INVESTIGATIONS

Experiments were performed on guinea pigs (cavia porcillus). These animals were chosen since they are handled easily in the laboratory and because the interscapular gland is well developed in rodents.

It was found that the fatty mass between the scapulæ was, in some cases, composed of yellow fat, but that in adult males, the fat was often of the brown variety. In some cases both forms were present, though they were fairly definitely demarcated from each other.

Under aseptic conditions, the skin was incised and the fat traumatized by crushing. The fat tissue was removed subsequently and examined microscopically. The result was an inflammatory reaction (Figs. 9, 10, 11, 12, 13).

In the yellow fat, the inflammatory cells appeared between the fat spaces, while in the case of the brown fat, the characteristic groups of "moruloid" cells (Fig. 14) also contained small round cells, endothelial cells, fibroblasts (Fig. 15), and a few polymorphonuclear leucocytes.

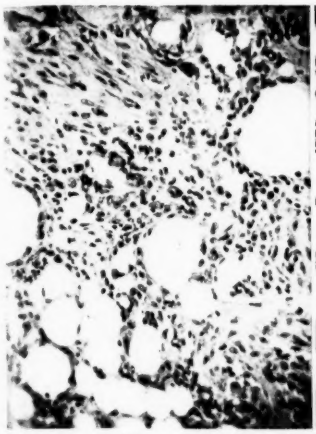
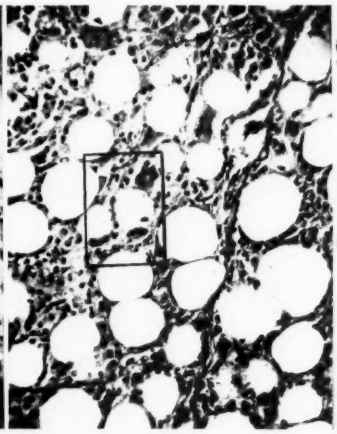


Fig. 11.



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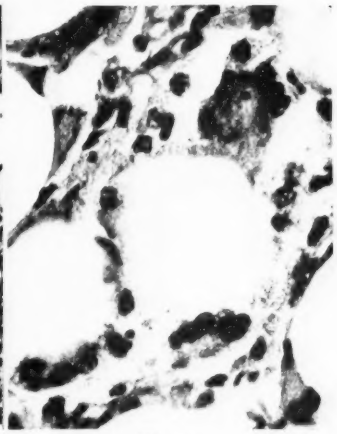


Fig. 13.

Fig. 11. Portion of a section of yellow fat, 24 days after aseptic trauma. Numerous phagocytic cells are present in the neighborhood of the fat spaces. ×135.

Fig. 12. Portion of a section of yellow fat, 6 days after aseptic trauma. The rectangle indicates the area of Figure 13. ×135.

Fig. 13. Phagocytic cells and giant cells are shown in relationship to fat spaces. ×600.

It is apparent from a perusal of the sections that the lesions induced in the brown fat of the guinea pig were similar to those found in the lesion described in the human cases, and the tissues in these, therefore, were considered to be inflamed brown fat.

DISCUSSION

In the 3 cases described, a nodule developed which microscopically showed a picture which suggested brown fat. In one of the cases (Case 3), the position is such as would be expected for the occurrence of such a lesion. Brown fat, in this site, is a well recognized anatomical and pathological entity. The occurrence of the hæmolymphglandular structure is also confirmatory in consideration of the work done by Bonnot.

In the second case, the presence of typical brown fat is of importance, since it establishes another hitherto undescribed site for the occurrence of this form of tissue—the posterior aspect of the anterior abdominal wall.

Lest some error of interpretation had been made, or the association of this tissue with the main part of the nodules were accidental, the experiments described above were performed. The picture produced in the experimental conditions was extremely like that observed in the specimens taken from human beings (compare Fig. 16 with Figs. 3 and 6).

It will be seen that the resemblance was both macroscopic and microscopic. On gross examination, the nodules were not the ordinary yellow color of fat tissue, but became brownish on preservation in formalin (in one case, Case 1, this color was obscured partially by the inflammation). On microscopic examination, under the low power, the tissue is seen to consist of lobules of tissue which contain cells, in closely packed formation, possessing vacuolated protoplasm and central nuclei. The tissue is more cellular than ordinary brown fat, but closer inspection shows this to be due to the presence of the cells of inflammation.

It was these observations that suggested that the conditions were due to the occurrence of inflammation in this brown or moruloid fat.

From this conclusion, important questions arise. For example, what is the relationship of these moruloid cells to those present in the cases of inflammation or fat necrosis occurring in ordinary yellow fat?

These cells have been described as fetal (Keynes), but this appears to be a misinterpretation, since Shaw has shown that the fat cells of the fetus are of the typical variety

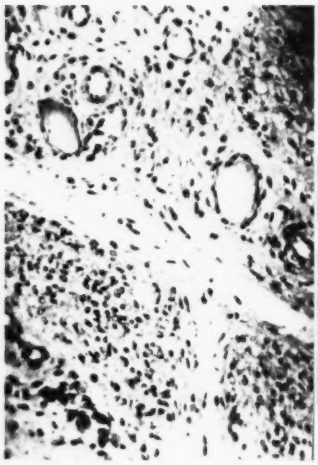
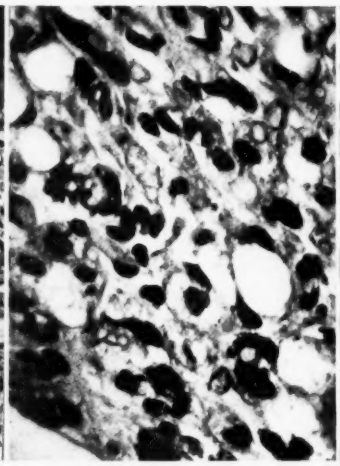


Fig. 14.



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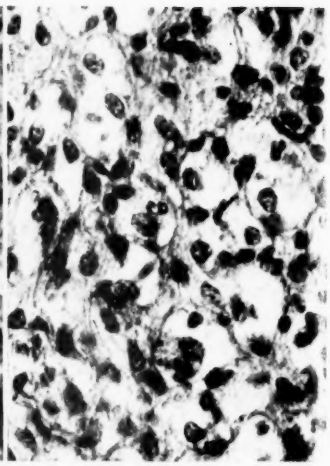

Fig. 16.

Fig. 14. Photomicrograph of a section of a portion of brown fat taken from a guinea pig 12 days after aseptic trauma. The arrangement of the characteristic cells in groups is well shown. ×135.

Fig. 15. Higher power view of the cells in the tissue shown in Figure 14. The cells have the typical arrangement of the fat globules and have central nuclei. There are a number of cells of inflammation between them. ×600.

Fig. 16. Another portion of inflamed brown fat tissue taken from a guinea pig, 10 days after aseptic trauma. The resemblance to the lesions in the human being is shown by a comparison with Figures 3 and 6. ×600.

containing one globule, but that a considerable portion of the fat tissue is of the brown variety. On the other hand, these cells closely resemble the phagocytic cells which are to be seen in any lesion where there is free fat. They contain the multiple small globules in their protoplasm.

It is necessary to review the evidence for the opinion that the tissue in the cases described is this special form of fat. The nodules examined were sharply delimited from the surrounding tissue. The inflammation spread into the neighboring fat, but the characteristic tissue had a definite margin. The inflammatory changes in the ordinary fat tissue were of the variety that is usually seen in fat tissue. At no place could a transition from one form of tissue to the other be found. In the typical portions of brown fat, no ordinary fat spaces could be seen, and even where these were present, there were so few that a conclusion that they were ordinary fat cells surrounded by a tremendous excess of inflammatory phagocytic cells did not appear a satisfactory hypothesis. Lastly, an examination of the cells in cases of inflammation in fat shows that they are wandering cells which are present in addition to the ordinary cells of the part. In the case of the specimens described, however, the cells appeared to be actually forming the tissue and other inflammatory cells could be found among them.

An interesting case was described by Fabyan. A child, after birth, was found to have a number of areas of fat necrosis in the subcutaneous tissues of various parts of the body. Fabyan described cells containing a large number of fat globules. These may have been phagocytic cells, but it is possible that this may have been an example of extensive distribution of brown fat. A difference in the type of fat is one of the simpler explanations for the sporadic occurrence of this necrosis. This is pure hypothesis, but the writer hopes to produce evidence in favor of this view later.

It has been suggested to me that the tissue in the cases described may arise by a reversion of the fat cells to this brown type. There are, however, several objections to this opinion. In the first place, this reversion has no prototype in embryology or physiology—the two forms of tissue are quite distinct. At this

stage of investigations, it is not possible to give any personal statement concerning the relationships of yellow and brown fat. Hence, though further investigation may modify the view, the evidence of other writers showing that they are distinct throughout the whole of their life history is accepted. Secondly, it seems improbable that pathological change would mimic, so closely, the normal structures as to give the appearances seen in some of the tissues examined. Then the moruloid cells are in remarkable excess of the very few fat cells present. One would not expect such a complete transformation throughout the whole of the tissue and lastly the change from this brown fat to the ordinary yellow fat in the neighborhood was abrupt. There were no gradations from one to the other.

From a consideration of these various arguments, together with the conclusions derived from the experimental work, the suggestion that the lesions are inflammation occurring in brown fat is considered to be on a firm basis.

Diseases occurring in brown fat have seldom been reported. The occurrence of neoplasms has been referred to, but inflammation in this tissue has not been recorded previously.

Since brown fat apparently has an inconstant distribution, it is not surprising that examples of disease should be of sporadic occurrence. At the same time its distribution is widespread, so that such disease may be found almost anywhere in the body (the exact distribution will be determined only by future research), but especially in the neck and retroperitoneal tissues and other well recognized sites of this peculiar fat tissue.

It will be seen that inflammation in this tissue may give rise to a definite, more or less localized, swelling, for example, in the abdominal wall, and a knowledge of this condition, both macroscopic and microscopic, is essential for proper diagnosis and treatment.

Attention is called to the lesions described, so that further observations may help to elucidate both the physiology and pathology of so called brown fat tissue.

SUMMARY

1. The occurrence, distribution, embryology, and physiology of brown fat is discussed.

2. Its occurrence in the posterior aspect of the interior abdominal wall and in the retroperitoneal tissue in the iliac region is described.

3. Three examples of inflammation in this tissue are described and discussed.

4. The relationship to other lesions is discussed.

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INFECTIVE GRANULOMA

Non-Specific Chronic Tumor-like Productive Inflammations of the Gastro-Intestinal Tract[1]

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I HAVE chosen to use this term of "infective granuloma" as it recalls to many clinicians a definite though non-specific disease entity. To some pathologists the term is a misnomer and should not be used. E. D. LeCount and Edwin F. Hirsch of the pathological department of St. Luke's Hospital, for example, designate these conditions as chronic productive inflammation or inflammatory hyperplasia and claim that the suffix "oma" refers to a true tumor.

Because of this objection I sought the views of six other leading pathologists and of several surgeons concerning the correctness or desirability of this title. James Ewing suggested a portion of the subtitle and stated further in his letter: "The term 'granuloma' does not signify tumor. It is applied to tuberculosis, syphilis, leprosy, Hodgkin's disease, and other infectious processes which produce local overgrowths resembling a tumor. The ending 'oma' strictly speaking does signify a tumor, but usage overrides all these considerations and justifies the use of the term as you propose."

W. F. Peterson, of the University of Illinois, replied that he could see no particular objection to use of the term granuloma because the term does not necessarily indicate a malignant affair but merely an overgrowth of tissue which may be either inflammatory or neoplastic. He suggested that the term "infectious granuloma" would be better.

Clinicians for so many years have used the title "infective granuloma" that it does not seem justifiable to change it unless some real objection can be found to the word "infective." Dorland defines "infectious" as: "Liable to be communicated by infection. An infectious disease is one caused by parasites, such as bacteria, protozoa, or fungi, and it may or may not be contagious." He defines "infective" thusly: "Of the nature of an infection; infectious." Since we are trying to define the nature of these granulomas rather than suggest, even remotely, the communicability of the infection, I believe the old title of "infective granuloma" should stand.

J. P. Simonds, of Northwestern University Medical School, in his letter gives the views of several other pathologists as follows: "I have your letter concerning the use of the term infective granuloma. This term, like many others in medical nomenclature, is recognized by pathologists to be faulty in many respects but it has in its favor long usage. In the minds of those who use the term it generally has quite a definite connotation. Karsner, Stengel and Fox, Beattie and Dickson, and Oertel use either infectious granuloma or infective granuloma. MacCallum and Mallory do not use the term at all. Delafield and Prudden do not employ the term and in a footnote criticize its use. They state: 'It may be doubted whether it is wise to group together, under a name suggesting tumor relationships which do not exist, lesions of such diverse origin and clearly of infectious character.' Aschoff in his *Pathologische Anatomie* instead uses 'spezifische Entzuendungen (infektioese Granulations-bildungen).' Ribbert in his *Lehrbuch der allgemeinen Pathologie* classes this condition under 'Die proliferativen Entzuendungen.'

"The term 'infective granuloma' therefore has usage in its favor but is open to very definite criticism. No satisfactory term has, however, been offered to take its place."

H. Gideon Wells strongly supports the clinicians' viewpoint. He says: "I can see no objection to the use of the term 'infective granuloma' for such conditions as you describe. Certainly usage does not justify the statement that 'oma' always refers to true tumor. It simply means a swelling, and the use of tuberculoma, syphiloma, etc., is uni-

[1] From the Surgical Clinic St. Luke's Hospital, Chicago, and Department of Surgery, Northwestern University Medical School.

versal. We announce annually in the University of Chicago catalog a course on the 'Specific granulomata.' 'Usage makes language' and the term granuloma has certainly a long enough historical background to justify its use. In this matter Doctor Esmond Long, who is our best authority on both history and etymology, agrees with me."

Finally, A. S. Warthin sums up the whole situation exceedingly well in his letter, as follows: "Replying to your letter of March 29, I do not see why you should not use the term 'infective granuloma' if you are sure that these masses of granulation tissue are due to chronic infection. Any large mass of granulation tissue, large enough to be regarded as tumor-like and due to any chronic infection, syphilis, tuberculosis, blastomycosis, etc., can be included under the general term of infective granulomata. The pathologists who contend that the suffix 'oma' always refers to true tumor usually overlook the fact that chronic infective granulomata represent a special class distinct from tumors, having been separated from tumors as soon as their etiology became known, and that we use this term constantly in speaking of tuberculosis, syphilis, actinomycosis, granuloma pyogenicum, condylomata, etc. The only objection I can see in its use for your paper is that some specific chronic infection is usually indicated. As long as you do not know the etiology but are sure they are infective granulomata I would suggest the title 'Infective Granulomata of the Gastro-Intestinal Tract of Unknown Etiology.'"

The surgeons consulted all seemed to agree that the term "infective granuloma" has had wide usage in the medical literature; that it conveyed the idea to them of an inflammatory tumor-like mass, invading some tissue or viscus whereas inflammatory hyperplasia indicated nothing but a hyperplasia of granulation tissue. They feel that the suffix "oma" has been used for so long a time in connection with tuberculosis, syphilis, and the other specific infections as to warrant its use in connection with these non-specific infections.

Considering the importance of this condition, especially in the differential diagnosis of obscure tumors of the abdomen, it is surprising how inadequately the medical literature of our own country has dealt with these inflammatory granulomatous masses as a definite entity. It has been mentioned and described time and again in articles dealing with chronic ulcers of the stomach and intestines; in chronic adhesive peritonitis; in certain types of diverticula; in omental hyperplasias; and in inflammatory masses developing about sutures in herniotomies. Others have described the condition under colitis and pericolitis following ulcers, polypi of the intestine, foreign bodies within the intestine, and infarction of the mesentery. In most of these articles the preliminary condition is stressed and the resulting inflammatory mass, often of such size as to give all the signs and symptoms of a tumor of the abdomen, receives secondary consideration.

One of the first clinical reports of these non-specific inflammatory tumors of the intestine, dealing with the subject as a definite entity, was made by Braun in 1909. Prior to then these cases were usually regarded as instances of "hyperplastic tuberculosis of the intestine."

In 1909, Le Dentu described similar cases under the heading "False Cancers and Inflammatory Tumors in the Abdomen." He subdivides these into four groups: (1) interstitial colitis, circumscribed in character, and associated with hypertrophy, resulting in a certain amount of stenosis; (2) simple pericolitis with adhesions; (3) diffuse pericolitis with the formation of an elongated mass; (4) exuberant pericolitis, in which form the intestine and extraperitoneal connective tissue and glands are all matted together.

In 1923, Eli Moschcowitz and A. O. Wilensky, under the title of "Non-Specific Granulomata of the Intestine" gave a clinical and pathological study of four cases with five specimens carefully examined. These authors emphasized the following facts: (a) its recognition thus far seems confined to European observers; (b) its literature covers only the last decade; (c) its interest is not entirely morphological but it is important from the standpoint of clinician and surgeon alike as it must be considered in dealing with obscure tumors of the abdomen.

In 3 of their reported cases the cæcum and ascending colon and in the fourth the splenic flexure of the colon were involved. In 2 cases the appendix had been removed for a suppurative appendicitis, and in the third case a chronic appendicitis was found in the mass removed by resection of the cæcum and ascending colon. In all 3 specimens a firm, tense, uncircumscribed tumor was found involving all the coats of the intestine, causing stricture of the lumen. In 3 cases there was superficial ulceration not involving the mucosa. In one specimen the main bulk of the tumor projected into the mesentery. In the fifth specimen a granuloma of the small intestine developed a year later, after resection of the ascending colon for a granuloma; almost a foot of the small bowel was involved in an uncircumscribed mass which encroached upon the lumen until it was almost obliterated.

Microscopically, these cases gave almost identical findings, viz.: interstitial infiltration of all the coats of the intestine with round cell or plasma cell type. They showed a wide variation of a fibroblastic transformation from a comparatively richly cellular tissue, to a firm, tense fibrous scar. New blood vessel formation was prominent in all specimens. In two specimens the presence of giant cells were noted, especially prevalent in the specimen from the small intestine. In 2 of their cases bacterial stains were made for tuberculosis bacilli and none was found. In none was there evidence of caseation. The Wassermann was negative in all cases.

DEFINITION

Infective granulomata are tumor-like masses influenced to a certain extent by a low grade, non-specific infection and characterized by a piling up of granulation tissue showing varying stages of necrosis, fibroblastic changes, and true scar tissue or reparative tissue growth. These masses, usually more or less non-circumscribed, often reach the size of an orange, a grapefruit, or occasionally a child's head. They do not include those specific infections the chief characteristic of which is the formation of tumor-like masses, often called specific granulomata such as the gumma of syphilis and the hyperplasias of tuberculosis, actinomycosis, blastomycosis, and anthrax. In this article the discussion is limited to those non specific inflammatory masses occurring in the gastro-intestinal tract although similar tumor like conditions occur in other parts of the body, notably in certain bone conditions, in infections of glands, and in other location surrounding foreign bodies or even abou hæmatomata.

PATHOLOGY

These inflammatory granulomata or hyperplasias are usually sterile. The underlying cause of their formation is some local interference of the blood supply to the given tissue followed by a small area of necrosis, followed by a reparative tissue reaction. The necrosing process may continue to progress slowly with corresponding increase in the reparative process—round cell infiltration, fibroblasts, connective tissue stroma, and new blood vessel formation—until a definite granulation tumor-like mass has formed.

In the beginning low grade infective organisms, usually staphylococci or bacillus coli, may be present and may cause a local tissue reaction which, due to round cell infiltration and fibrosis, may in itself so interfere with the circulation as to result in the slow piling up of the chronic granulation tissue. Or such an inflammatory mass may later in its course become invaded by pyogenic organisms even to the point of abscess formation. But as a rule these granulomatous masses soon become or remain sterile.

The inflammatory hyperplastic masses correspond to the infective granulomata first described in this country by Senn. He described a granulomatous tumor the result of a necrosis of tissue, usually due to some mechanical constriction of blood supply to the involved tissue, followed by a low grade infection, followed by a reparative process. The necrosis, low grade infection, and reparative process go hand in hand occurring simultaneously, but the reparative process predominates, resulting in a piling up of granulation tissue until a tumor-like mass is formed. In other words, we have a breaking down and a building up with the latter conquering.

Without question, inflammatory adhesions, thickenings of the omentum such as are found

in the neighborhood of infections, or when constricted in a hernial sac, fibrosis about the site of an ulcer, and these larger masses of inflammatory hyperplasias are all of similar causation and developmental process. The latter differs in the degree of momentum and period of activity, the piling up of granulation or reparative tissue continuing as long as the infective or necrotic process remains unconquered. Thus, if no dire result occurs, such as an obstruction of the bowels, the granuloma may grow to the size of an orange or a grapefruit, may become irregular in shape, may include adjacent tissues in its mass, and may possess areas of softening or ulceration and other areas of indurated firmness, and withal may so resemble a malignant tumor that it can deceive the keenest observer. Neighboring glands are frequently enlarged thus adding to the deception. And if at operation a small piece of the tumor is removed and given to the pathologist for frozen section and immediate report, the surgeon may be even further confused. In two of the cases hereinafter reported the frozen section report in one was carcinoma and in the other, small round cell sarcoma. It was only after repeated studies of more carefully prepared sections that the true diagnosis was established, and was verified by the subsequent course of the two cases.

Microscopically, such a granuloma reveals a mass of chronic granulation tissue in which the chief elements are mononuclear cells and lymphoid cells. Other areas are densely infiltrated with polymorphonuclear leucocytes. The picture may vary from fibroblastic and lymphoid tissue surrounding areas of necrosis to well defined connective tissue stroma with developing blood vessels, depending upon the age of the hyperplasias. Occasionally, large mast cells resembling giant cells are seen. An area containing these mast cells and large groups of lymphoid cells can easily be mistaken for carcinoma while the small round cells may so predominate the picture as to make it resemble sarcoma.

ETIOLOGY

The etiological factors which predispose to infective granulomata formation are:

Fig. 1. Drawing submitted by Professor Bumm, describing a "cancer" in left ovary and sigmoid which was unquestionably an infective granuloma (see Case 1).

1. Conditions existing within the gastro-intestinal tract itself or its mesentery;
2. Extraperitoneal infections which gradually spread to and involve the gastro-intestinal tract;
3. Trauma. (a) surgical trauma or accidents, (b) extraneous injuries.

My cases include examples of all three of these groups but by far the commonest cause was trauma.

1. Conditions existing in the gastro-intestinal tract itself. Certain types of sigmoid diverticulitis furnish the best examples of the condition. The diverticulum with a small opening on the mucosa but with a balloon-like protrusion on the peritoneal surface, often contains a small amount of hard, inspissated fæces. Erosion, low grade infection, necrosis, round cell infiltration of the adjacent mesentery, with this reaction extending upon and around the adjacent bowel, kinking or constricting the bowel, and all of this accompanied by the peritoneal and omental tissue reaction to inflammation soon gives a granulomatous mass about this diverticulum that is almost

Fig. 2. Infective granuloma of stomach thought on gross examination to be carcinoma. No previous ulcer history. (See Case 3.)

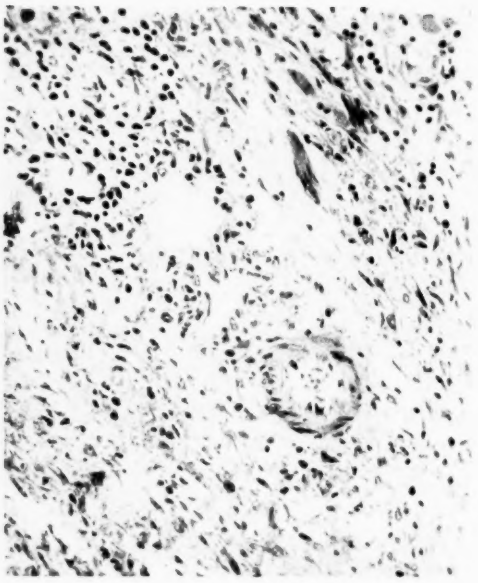

Fig. 3. High power field of infective granuloma of stomach which is seen in Figure 2. Patient has remained well since operation.

impossible grossly to distinguish from a malignant tumor. Such a condition may develop in and about diverticula anywhere in the intestinal tract. Author's Case 1 is the best example of this condition (Fig. 1).

A preliminary paper was given 3 years ago before the Pennsylvania Railroad Surgeons Association. In the discussion, one of the surgeons told of the case of his brother. Five years previously he was operated upon for a tumor of the sigmoid. This tumor was diagnosed as carcinoma and was considered inoperable. A colostomy was done. This patient 5 years later was in good health, the evidence of malignancy had disappeared, but the colostomy still functioned. Efforts were made to persuade this brother to submit to examination with the possibility of closing the colostomy, but he refused. In all probability this was an infective granuloma and not a malignancy.

Typical of quite a number of unreported cases which I have collected from different surgeons is the following:

Dr. M. H. Cremer of Red Wing, Minnesota, writes concerning patient F. H., farmer, aged 62 years. His chief complaint was of stomach trouble of 2 months' duration. During the past 2 weeks he has had distressing pain in the abdomen, not associated with eating, and bowels had been constipated. The examination, including X-ray examination, was negative except for a small inguinal hernia and a small epiplocele just above umbilicus; stomach analysis negative. He was placed on medical treatment. Three weeks later patient returned for exploratory operation. No pathological change was found in stomach or intestines. The herniæ were repaired. Patient grew gradually worse and on February 24, 3 months later, a barium meal revealed an intestinal obstruction. Patient was re-operated upon on February 27. A granulomatous mass with a tight constriction of the colon at the sigmoid flexure was found. The bowel above was distended; below, collapsed. A four-inch resection was made. The microscopic examination showed "inflammatory plastic tissue—no malignancy." The follow-up report shows that patient gained 30 pounds and was quite well one year later.

Braun, in his article, reports a case of a woman aged 43 years who had a tumor the size of an orange in the left abdominal cavity of 8 weeks' duration. A diagnosis of carcinoma was made. At operation a mass in the sigmoid flexure involving chiefly the

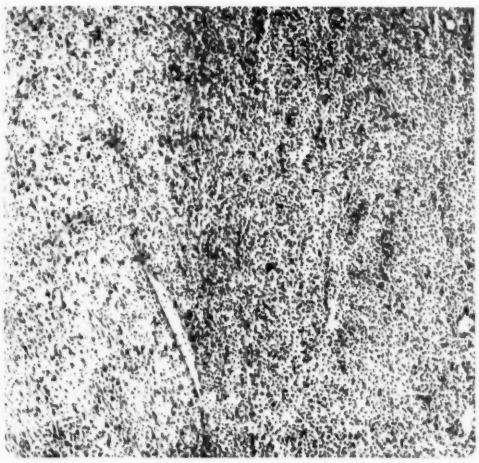

Fig. 4. Photomicrograph of infective granuloma described in Case 6.

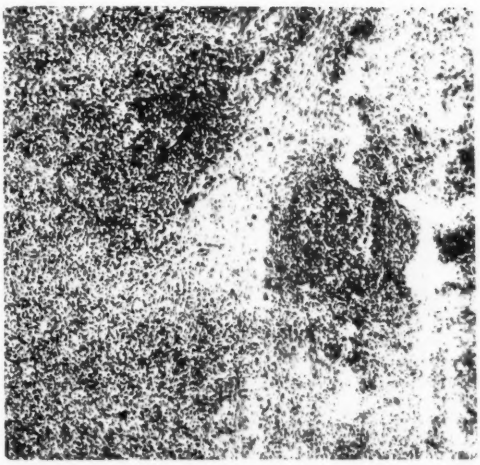

Fig. 5. Photomicrograph of infective granuloma described in Case 7.

mesentery aspect was found. On removal it was found to be fatty tissue with connective tissue infiltration but no signs of malignancy. He presented this as an example of a granuloma around a diverticulum.

Neupert reports a tumor case diagnosed at operation as inoperable carcinoma in which there was perforation of one or more diverticula into the mesosigmoid. He describes the tumor as made up of connective tissue formation and cicatricial contraction of the mesentery.

Monsarat reports a case of a man aged 44 years who had suffered abdominal pain, vomiting, and distention for 6 months with an obstruction for 8 days. Examination revealed a firm, tender, and movable mass in the left lower quadrant. A granulomatous mass about the size of an orange was removed at operation from the sigmoid loop. Microscopic examination showed the tumor to be due to a mass of cicatrix and inflammatory infiltration—a perisigmoiditis with considerable exudate. Monsarat reports a second case of a man of 47 years who had constipation for one year and later blood in the stools. Examination revealed a mass in the left lower quadrant. Diagnosis of malignancy was made. At operation the mass proved to be a granulomatous tumor.

The inflammatory hyperplastic mass developing at the site of a gastric ulcer, usually following a small perforation, is another well known example. It is a known fact that these are frequently mistaken for cancer. The differential diagnosis is rendered more difficult because of the enlarged glands. Ulcers existing anywhere in the intestinal tract may act similarly (author's Cases 2, 3, and 4—Figs. 2 and 3).

Dr. Edward Doepp, of Blue Island, Illinois, and Dr. George Scupham, of Homewood, Illinois, recently told me of performing several years ago an abdominal operation for tumor. They found a large tumor of the greater curvature of the stomach. It was quite characteristic of malignancy and was, in their judgment, inoperable. The abdomen was closed and the family told of the presence of cancer. This patient is still alive and in good health. Many a surgeon, with a sense of chagrin, can report similar cases.

Polypi of the intestine may undergo necrotic changes followed by reparative inflammatory reactions and may develop tumor-like masses sufficiently large as to cause intestinal obstruction. These polypi are frequently mistaken for carcinomata.

Foreign bodies within the intestines and even hard, inspissated fæces in old people may likewise start this inflammatory reaction, resulting in a tumor-like formation.

Jaffee and Morian both describe simple granulomata forming in the intestines about portions of bone. Others have described inflammatory thickenings with adhesions about foreign bodies in the intestine. Many remem-

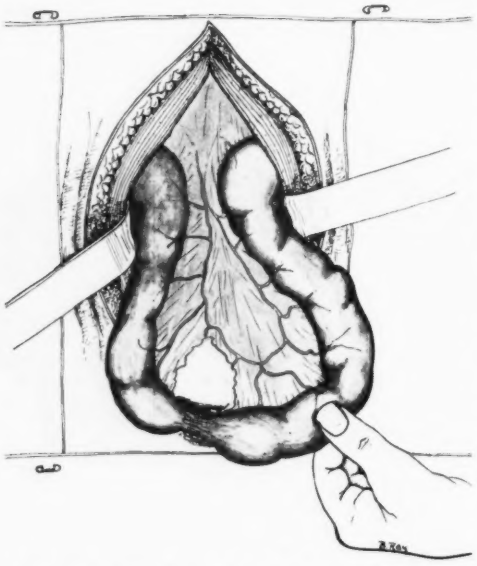

Fig. 6. Drawing of constricting infective granuloma of small intestine the result of a traumatic tear in the mesentery.

ber Senn's famous case of the man who ate fruit cake 9 months previously and at operation this cake formed the nucleus of a "granuloma."

Hyperplastic colitis, a form of pyogenic colitis, is a condition described by Alexius McGlannon in Lewis' *Surgery*. It follows invasion of all the coats of the bowel by pyogenic organisms:

"The hyperplastic form represents a vigorous reaction to the invading organisms, which shows itself in the production of a circumscribed mass of inflammatory tissue. The cæcum and ascending colon are the segments usually involved. The bowel wall is thickened by infiltration with inflammatory products and the lumen is narrowed by the swelling. Necrotic areas with leucocytic infiltrations and giant cells are found scattered through the inflammatory mass. The mucosa may be, but is not always, ulcerated. The mesenteric glands are enlarged, and there are adhesions about the mass."

Such a condition as this author here describes may develop in the intestinal wall at the site of a solitary ulcer, as the result of an infected appendix or diverticulum or of an infected mesenteric lymph gland; it may be caused by a mesenteric infarction resulting in a localized necrosis of the bowel or from a foreign body wound of the intestine—a penetrating wound from without or one from within the gut itself. The resulting condition is a typical granuloma. At times, however, the cause of this hyperplastic colitis or granuloma cannot be ascertained.

Moynihan reports the case of a man aged 62 years with intestinal trouble of 3 months' standing and with acute obstruction:

A tumor mass in the left upper quadrant could be felt. A diagnosis of carcinoma was made. On operation a tumor the size of a cocoanut was found in the transverse colon. The transverse colon was red, thickened, and distended, while the descending colon was pale and empty. Anastomosis was made between the sigmoid flexure and the distal end of the ileum as removal of the mass was impossible. Patient made a complete recovery and in a short time there was complete disappearance of the tumor.

A partial volvulus or partial obstruction from bands of adhesions may set up a low grade pericolic inflammation which does not cause such marked reaction in the gut itself but which causes a hyperplastic reaction in the adjacent omentum until it is so thickened and enlarged that it resembles a good sized tumor (author's Case 5).

Proust reports the case of a woman aged 32 years who had a progressive tumor. Some time previously she had had a laparotomy performed. At operation the tumor was found to consist of adherent thickened omentum, the lumen of the colon being constricted by a projecting spur of the mass. Microscopically it showed inflammatory thickening and sclerosis but no malignancy.

Finally, constriction of the bowel and omentum in hernial sacs, both external and internal herniæ, may result in an inflammatory hyperplasia until the whole is matted together in a tumor-like mass.

2. *Extraperitoneal infections which may gradually spread to and involve the gastrointestinal tract.* A low grade infection in the retroperitoneal lymph glands may cause a necrotic mass, showing areas of reparative fibroblastic reaction, which gradually involves the parietal peritoneum or involves the colon at its splenic flexure, causing the usual

peritoneal and omental reaction to inflammation, until a large, more or less necrotic, more or less solid tumor-like mass has formed in and about the colon, often resulting in obstruction and usually very difficult to differentiate grossly from a malignant tumor. Case 6 illustrates this condition very well (Fig. 4).

Occasionally, without any discoverable atrium of infection, a patient develops swollen inguinal lymph glands, and a mass of infected glands just above and under Poupart's ligament can be palpated. The mass gradually enlarges and after several weeks shows evidence of pus. At operation the parietal peritoneum is involved and the iliac vessels are intimately attached to the mass.

In one such case of mine, the mass bulged into and involved the intraperitoneal cavity near the cæcum. In attempting to free the granulomatous mass, it was opened and pus escaped. Simple drainage was instituted. The pathological report stated that the mass was made up of chronic granulation tissue. No secondary operation was performed as the mass disappeared and patient completely recovered. There has been no evidence of recurrence in this case operated upon 8 months ago.

Just as a diverticulitis of the sigmoid can form a huge mass and involve the bladder in its extension, with a subsequent rupture into the bladder and the formation of a vesico-sigmoidal fistula, so can the process be reversed, the extension taking place from the bladder to the sigmoid or other intestinal loop.

Dr. Harry Culver, 2 years ago, asked me to assist at an operation upon a patient with a vesico-intestinal fistula. In this instance if the fistula had not developed the mass could easily have been mistaken for an extension of a malignant process from the bladder:

Patient had been treated first with a cautery for a papilloma of the bladder some 2 years previously. This was followed by the application of a needle of radium to the area. For 1 year patient had had signs of a vesico-intestinal fistula. At operation we found a fairly large mass extending from the bladder wall to the sigmoid. This was carefully freed, exposing the opening in the sigmoid and in the bladder with the fistulous tract about 2 inches in length running through the mass. The mass and tract were removed and the openings in sigmoid and bladder were closed with pursestring sutures. Patient made good recovery; no sign of recurrence after 2 years.

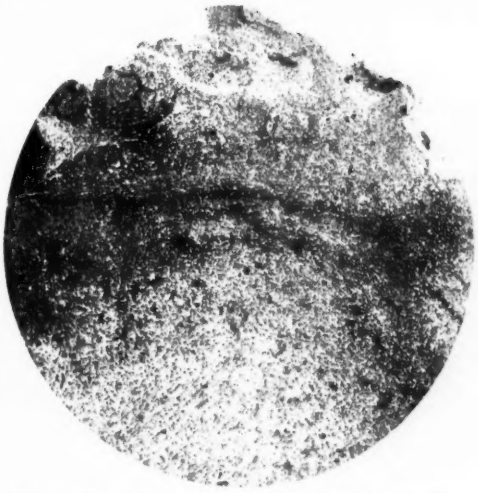

Fig. 7. Photomicrograph of case described in Figure 6.

Constriction of a hernial sac with the chronic inflammatory changes in the omentum within the sac, the adhesions to the involved loop of bowel, the thickening of the walls of the sac, and the extension of the low grade inflammatory reaction to or from the extraperitoneal tissues, especially the glands, gives one of the best examples of this chronic inflammatory hyperplasia due to the interference to circulation at the constricting neck of the hernial sac.

3. Trauma—surgical accidents or extraneous injuries. The importance of trauma in the formation of these obscure intra-abdominal tumor masses, so often mistaken for malignant tumors, has never been sufficiently stressed. No case of granuloma the direct result of an accident, such as from an automobile or a fall, has ever been reported, I believe.

Under surgical traumas or extraneous accidents we have the following examples: (1) ligatures or sutures which constrict and act as a local interference to the blood supply, or sutures which act as a foreign body; (2) foreign material, such as instruments, sponges, etc. left in the intra-abdominal cavity; and (3) trauma in general.

In one of my cases (Case 7) the inflammatory granulomatous mass developed around

Fig. 8. Traumatic hernia containing an infective granuloma protecting an undiagnosed tear of the small intestine.

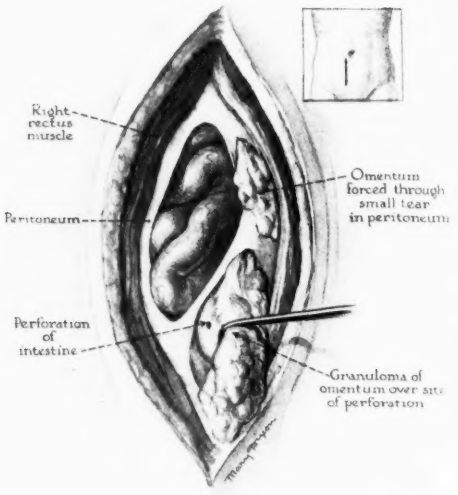
Right rectus muscle
Peritoneum
Perforation of intestine
Omentum forced through small tear in peritoneum
Granuloma of omentum over site of perforation

Fig. 9. Schematic drawing of condition illustrated in Figure 8.

the linen pursestring suture applied during an appendectomy several months previously (Fig. 5).

Teitze reports a "granuloma of the cæcum following an appendectomy" and in the center of the tumor mass the silk pursestring suture was found.

L. L. McArthur tells me that he observed a similar granulomatous tumor mass about the silk ligatures of a gastro-enterostomy. I have operated upon one case who, 5 years previously, had had a gastro-enterostomy performed, and found such a large mass of chronic inflammatory tissue that I could not remove it. Later, another surgeon operated and succeeded in removing the mass. Many have noted a subsidence of the condition after simply exposing the mass. This may have accounted for the success of the second surgeon.

Cases have been described of gangrene and pericolic masses following undue ligature of the mesentery.

Massive ligatures of the omentum have likewise resulted in inflammatory hyperplasia with adhesions extending to and matting together adjacent loops of bowels. Chronic inflammatory enlargements of the stump of the omentum following ligation of a portion of it for hernia or appendicitis were first described by Coley, in 1901, and later by Braun. In 1907, Le Roy gave an exhaustive study of the condition. Bull, as early as 1893, described a case of enlargement of the omentum, which occurred months after an operation and resembled malignant growth.

Chronic inflammatory tumor masses of the abdominal wall following the use of non-absorbable suture material have been described. Schlosser reports 4 cases of radical operation for hernia in which silk buried sutures were used. In 2 cases there were infections and in 2 primary union: Later the appearance of a mass or a swelling about the scar, the swelling appearing within several months in 2 cases, 1½ years in 1, and 5 years in the fourth. Re-operation in each case revealed connective tissue masses with the sutures the nucleus in each mass. Small amounts of pus were present in each case and in two staphylococci were found. Richter reports a case of abdominal wall tumor around metallic sutures used in a hernia.

2. Foreign material, such as instruments, sponges, etc. left in the intra-abdominal cavity is a surgical accident productive of these inflammatory granulomatous masses.

In 1920, a patient was admitted to the service of A. E. Halstead at St. Luke's Hospital (H. E. Mock, Junior on Service):

For the last year patient had noticed a swelling gradually increasing in size in the upper right quadrant of the abdomen. Occasionally he had had chilly sensations and slight fever. For one week previous to operation, tenderness had developed over the upper abdomen. There was some loss of weight, not marked. The diagnosis was tumor or abscess of the liver. Patient had been operated upon in another city for gall stones some 10 years previously. He had been in good health until 1 year ago. At operation we found a large, solid tumor, apparently of the liver, containing areas of necrosis on the surface. It was possible to free this tumor from the anterior surface of the liver by blunt dissection. The tumor was about the size and shape of a large placenta, some 4 inches in thickness. Dr. Halstead thought it was most probably a sarcoma. Later, in the laboratory, it was found to be a granuloma formed around a small towel evidently left in the belly at the gall-bladder operation. Patient recovered.

Wagner reports a case in which a tumor following laparotomy occupied a large portion of the abdominal wall:

The tumor was adherent to the cæcum and omentum. At operation it was thought to be a sarcoma, and microscopic examination failed to reveal whether it was a sarcoma or an actinomycosis. Later, when the dressing was being done, a large abscess cavity was found containing part of a metallic instrument used at the original operation.

3. Under traumas in general many interesting examples of the development of these granulomata can be found:

Author's Case 8 is descriptive of an obscure injury to the abdomen, resulting in an undiagnosed tear of the mesentery followed 3 months later by an intestinal obstruction due to the formation of a constricting tumor mass which proved to be inflammatory. I have found no reports of a similar case (Fig. 6).

Case 9 illustrates another tumor mass due to a severe blow on the abdomen which resulted in an undiagnosed rupture of the small intestine (Figs. 8 and 9).

In Case 10 the tumor mass was more rapid in formation and resulted from a small tear in the mesentery and a partial volvulus and a piling up of an inflammatory reaction in the omentum.

Dr. S. W. McArthur gave me the following unreported case in which he feels that trauma was the exciting cause:

In 1925, a man engaged in steel riveting consulted him because of a swelling in right lower quadrant. It was so prominent that the doctor could see the swelling plainly as the man lay on the examining table. It was a hard tumor which had been increasing in size for several weeks. At operation a tumor the size of a cocoanut and involving the cæcum and with loops of gut adherent to it, was exposed. A diagnosis of malignancy was made. A small section was removed for biopsy as the tumor was considered inoperable. The laboratory report came back as chronic inflammatory hyperplasia. The man recovered and within 3 weeks the mass had disappeared. Four months later there was a recurrence of the condition and Dr. McArthur again operated upon him. At this time he removed an inflamed appendix from the center of a re-forming mass.

This patient held the blunt end of the riveter against his abdomen, making strong pressure exactly over the appendix region. It was thought that this long continued trauma accounted for the chronicity of the condition.

Foreign bodies involving the intestinal tract or left in the abdomen by surgeons have been mentioned. Foreign bodies penetrating and remaining in the abdominal cavity likewise form the nucleus of a granulomatous mass.

Dr. George W. Morse, of Boston, has written me of a case injured by a board flying back from a circular saw and striking patient forcibly in the abdomen:

Patient was treated for severe contusion and laceration of abdominal wall without operation. A year later patient developed a tumor in the abdomen in region of umbilicus and extending partly into right lower quadrant. Laparotomy revealed omentum and intestines more or less adherent over a tumor mass which seemed to be retroperitoneal. In exposing this mass more thoroughly it ruptured and pus escaped. It seemed to be thick, somewhat necrotic granulation tissue and in the portion containing pus a splinter of wood approximately 3 inches long was found and removed. Drainage only was done with complete recovery of the patient.

All of the conditions mentioned form the etiological basis for the development of these infective granulomata, so uniformly characteristic in their behavior that they deserve to be considered as a definite pathological entity.

SYMPTOMATOLOGY

The symptoms can be divided into three types: (a) inflammatory, (b) obstructive, and (c) constitutional. In some cases only one of these conditions will exist, while in others all three may co-exist.

Inflammatory type. In the inflammatory type the condition is characterized by varying degrees of abdominal pain, usually mild, nausea or vomiting, and local tenderness. As a rule these symptoms are of long standing and there is a history of relief and exacerbations. Fever, seldom more than 100 degrees, is frequently present but not constant and is occasionally accompanied with chilly sensations. A leucocytosis of 12,000 to 15,000 is generally present with polymorphonuclear cells predominating. The picture may never exceed that of a low grade infection while in a few cases a severe attack may develop which resembles acute appendicitis or diverticulitis.

On examination, a definite mass or indurated area can frequently be palpated. This usually is so definite that a tumor is at once thought of.

Obstructive type. The chief symptom is exacerbations of colic-like pain and constipation finally developing into the severe abdominal pain and obstipation of a partial or complete obstruction. Usually by the time obstruction symptoms develop, the low grade fever, leucocytosis, and local tenderness have also become a part of the picture.

The finding of the tumor mass with obstruction practically always results in a diagnosis of carcinoma. Or, if the inflammatory symptoms accompany those of obstruction a diagnosis of tuberculosis of the bowel is often made.

Constitutional symptoms of loss of weight, loss of appetite, anxiety neurosis, especially fear of a malignancy, are frequently present.

X-ray examination will usually reveal evidences of obstruction in the obstructive type, whereas this evidence is usually absent in the type giving inflammatory symptoms. Early X-ray pictures are frequently negative whereas a later X-ray film in the same case reveals a defect or developing obstruction. The X-ray often only further confuses the diagnosis. On the other hand, escape of the barium into finger-like projections, pouches, or pockets in the mass is very suggestive of granuloma. Care must be used in selecting the case for X-ray examination as the barium meal may produce complete obstruction in the partially obstructed case.

DIAGNOSIS

The terms "pseudo-tumors" and "false cancers" are sufficient to indicate the great difficulty of differentiating these inflammatory masses from true tumors. They are usually diagnosed as carcinomata, less frequently as tuberculosis of the intestine, and occasionally as sarcomata. Several authors state that the diagnosis is impossible prior to operation. (Kocher.)

As one becomes more and more interested in these strange granulomatous masses, he is led to suspect the condition more often and thus will be able to diagnose some of the cases prior to operation. The low grade fever, the leucocytosis, the history of some of the traumas that often precede the condition with the finding of an obscure mass, warrants a probable diagnosis. If the X-ray findings show the finger-like projections into the mass, his diagnosis is strengthened.

The following short résumés of incorrect diagnoses best illustrate the differential diagnosis:

Tumor of the liver. Mrs. B., daughter of a former professor of Rush, referred by Dr. S. S. Slaymaker with a diagnosis of gall stones; had typical colic-like attacks, slight temperature, jaundice, and leucocytosis of 28,000. She was operated upon by the author, and several large gall stones were removed. Patient made an excellent recovery and was discharged after 3 weeks, temperature normal, wound healed, but with a leucocytosis of 24,000 still present. After 6 weeks, she began to have a slight fever and increase of white count to 36,000. She returned to the hospital and after several consultations it was decided that a liver abscess was present. Again operation was done and one bluish-red nodule the size of an English walnut was found on the anterior surface of the liver. Aspirating needle exploration of the liver in all directions failed to reveal an abscess. Small sections of this nodule were removed and laboratory diagnosis was "inflammatory hyperplasia." Search of the literature revealed that Ewing had described a solitary bluish nodule of the liver under Hodgkin's granuloma. Patient had periods of improvement and then exacerbations of fever with increasing white count, finally reaching 78,000. Death occurred 10 months later. At autopsy three of these

small tumor masses of the liver were found, also enlarged mesenteric glands with bluish pigmented cut surfaces. Final correct diagnosis was lymphosarcoma.

Granuloma of pancreas, diagnosed carcinoma. Mrs. H., referred by Dr. N. C. Gilbert with a diagnosis of gall stones with common duct obstruction. Patient had had her first attack of gall-stone colic on Saturday and entered the hospital on Monday. She had a temperature of 100 degrees, marked tenderness and rigidity over gall-bladder region, and severe jaundice. She was operated upon on Thursday. Two large gall stones were removed. There was no stone in the common duct, but a stony, hard mass, the size of a baseball and involving three-fourths of the pancreas was found. Fine, recently formed fibrinous adhesions bound the duodenum and stomach and some of the omentum to the mass. Enlarged glands were also present. Several doctors present at the operation, who could easily see the tumor, agreed with me that this was very probably carcinoma. A small section was removed for biopsy. We were so positive of our diagnosis that Dr. Gilbert and I told the husband that his wife probably had cancer. Laboratory diagnosis after a week was inflammatory hyperplasia of pancreatic tissue. Patient made an excellent recovery. With drainage of gall bladder, jaundice disappeared within 2 weeks. No mass could be palpated after wound had healed. Patient is in good health after 8 months. She has gained 25 pounds in weight.

Inflammatory granulomatous mass of pyloric end of stomach, diagnosed carcinoma (see Case 2).

Inflammatory mass of pyloric end of stomach, diagnosed gall stones (see Case 3).

Carcinoma of cæcum, diagnosed infective granuloma. H. B., aged 40 years, switchman; gave a history of having had appendix removed 1 year previously. He entered the hospital on account of pain in the lower right quadrant, obstructive symptoms, and loss of weight. A mass could be palpated in the neighborhood of the cæcum. Coming shortly after Case 7 (granuloma with pursestring suture in center of mass) and with similar symptoms, I diagnosed the condition as granuloma. Wassermann reaction was negative. Operation disclosed a circumscribed mass which could be freed and removed by resection of cæcum and anastomosis of ilium and ascending colon. Laboratory study proved this to be a true carcinoma.

Actinomycosis of sigmoid, diagnosed carcinoma (Gilbert), infective granuloma (Mock). Miss F., aged 55 years, referred by Drs. Harry Culver and N. C. Gilbert with a diagnosis of carcinoma of the sigmoid. Patient had been sick 3 months with weakness, loss of weight, and slowly increasing obstruction symptoms. X-ray study showed a constriction in sigmoid but with irregular projections of the barium into a mass about the sigmoid. Because of these findings, Dr. Jenkinson of the X-ray department and the author diagnosed a diverticulitis with granuloma. Operation revealed a large mass the size of a cocoanut with semi-necrotic areas and involving the left tube and ovary. The mass could not be removed, therefore a section was taken and also the left ovary was removed. A colostomy was performed. Pathological study of section and of ovary revealed the condition to be a specific granuloma due to actinomycosis. Patient died 2 weeks later.

Infected mesenteric lymph glands. This patient, a boy 18 years old, gave a history of severe tonsillitis 6 weeks previous to entrance to the hospital. On admission, he had severe pain in the left perinephritic region, marked tenderness and rigidity in same region with extension over the upper part of the left abdomen. Temperature was 102 degrees and white count 18,000. Diagnosis of perinephritic abscess was made, and the patient was operated upon by the genito-urinary service No abscess was found. The wound was closed. Patient continued to have a temperature and high white count and 1 week later he was referred because of possible abdominal condition. A point of extreme tenderness and suspicion of a mass were located over the descending colon. Diagnosis of possible diverticulitis with granuloma or "this is possibly a case of enlarged mesenteric glands and retroperitoneal glands, the result of severe tonsillitis. Because of the obscure nature of the findings, feel justified in laparotomy" (case note). Operation revealed a definite enlargement of the mesenteric glands and glands could be felt retroperitoneally; no other pathological findings. Patient made a good recovery. A later X-ray of the gastro-intestinal tract revealed a small duodenal ulcer which Dr. Jenkinson of the X-ray Department felt showed a perforation. This may have been the source of the infection.

Tuberculous granuloma of intestine. This is a condition usually found in children or very young people. The cæcum is the commonest site of the tumor mass. Bovine tuberculosis is more often the cause of the condition. The differential diagnosis from an infective granuloma must usually be made in the laboratory.

Syphilitic gumma of the gastro-intestinal tract is rather rare. The slow progress of the condition and the positive Wassermann warrant instituting antisyphilitic treatment and the disappearance of the condition leads one to this diagnosis.

Anthrax and blastomycosis must be considered but here again the true diagnosis will usually be made later in the laboratory.

TREATMENT

It is my experience, and many authors so state, that frequently these tumors disappear after sidetracking of the intestine or even after simple exposure of the tumor mass.

When the inflammatory nature can be diagnosed at operation, and obstruction symptoms are absent, local removal, or, if pus is present, drainage only will usually result in cure.

When definite obstruction is present resection of the bowel or, if the tumor is so extensive that this is impossible, a sidetracking anastomosis is necessary.

When on exploring the abdomen, one finds a large inoperable mass and is quite positive that this is malignant, he should nevertheless remove a section for biopsy. The laboratory study may reveal the condition to be an infective granuloma. Thus the surgeon will avoid making a fatal prognosis on a so-called cancer case that later recovers.

If, after deciding the tumor is malignant and inoperable, the biopsy proves it to be infective granuloma then one should wait to see if the mass will disappear. But if the inflammatory symptoms persist or if obstructive symptoms develop then one should certainly re-operate.

CASE REPORTS

CASE 1. Five years ago, Mrs. S. B., 60 years of age, a widow of a Chicago physician, was referred to me by Dr. Eugene Talbot, for operation on account of gall stones. In securing her history she related that 19 years previously she was in Berlin when she became sick. She cabled her husband who advised her by cablegram to consult Prof. R. Dittmar. She did so and a tumor in the lower left quadrant of her abdomen was diagnosed. Prof. Bumm, a noted surgeon, operated and found an inoperable carcinoma. The patient was told of her condition, and a letter with drawings of the tumor mass was sent to her husband. This patient gave me the original drawing of this tumor, made by Prof. Bumm, who explained in a footnote that the tumor was inoperable carcinoma of the left tube, left ovary, and sigmoid (Fig. 1). Patient stated that for 2 years following this operation she was an invalid expecting any day to die but at the end of that time she began to realize that she was growing better and stronger every day. Meanwhile her husband died, fully expecting that his wife would soon follow him to the better land. But with the exception of gall stones she has been in excellent health all these years. Her one request was that at this operation for gall stones, I should explore her sigmoid to see what had become of her cancer. On opening her abdomen with a wide incision, and before removing a large number of gall stones, I carefully explored the entire abdominal cavity and especially the left lower quadrant. There was absolutely no sign of a tumor mass nor even adhesions at the site of the original condition. Knowing the reputation of Dr. Bumm, one must acknowledge that a tumor-like mass existed, but it must have been an inflammatory mass possibly arising from a diverticulitis of the sigmoid forming an infective granuloma instead of an abscess. Patient is still in excellent health.

CASE 2. Miss T. S., aged 56 years, entered St. Luke's Hospital, April, 1928, on service of Dr. N. C. Gilbert. She gave a history of stomach distress for years with vomiting shortly after meals and marked loss of weight during the last 3 months. Her weight at this time was down to 86 pounds. X-ray examination showed a constricting defect near the pyloric end of the stomach. She was referred to author for operation with the diagnosis of carcinoma. A gastroenterostomy seemed indicated to relieve her starvation and vomiting. On exposing the stomach a mass the size of an orange was found involving all the pyloric end of the stomach. There were many enlarged glands along the greater curvature of the stomach but no nodules on the liver. The mass was freed from the pancreas and surrounding tissues and it was felt that a stomach resection with removal of this malignant growth was possible and therefore this was done and successfully. Even after removal we were positive the gross specimen was carcinoma and the relatives were so informed. A few days later the laboratory report came back with the diagnosis of "inflammatory granulomatous tissue." Patient made good recovery and at the end of a year had gained weight to 140 pounds. She is still in good health.

CASE 3. Mrs. J. W., aged 52 years, married, no children, developed a sudden acute pain in upper abdomen while away on vacation in February, 1929. Pain was colic-like in character and accompanied with profuse vomiting. She was advised to return home at once and went directly from train to hospital. Examination revealed marked tenderness and rigidity in upper abdomen, pain shooting to right shoulder. Patient was still vomiting but no blood was found in vomitus. Temperature was normal, leucocyte count 12,000. No jaundice. Diagnosis of gall stones with possible empyema of gall bladder made. At operation, gall bladder was normal, but a tumor the size of an orange and involving most of the lesser curvature of the stomach was found. This was thought to be carcinoma. After considerable difficulty, a stomach resection was done, almost two-thirds of the stomach being removed. The pathologist and internist both agreed with author that the gross specimen resembled carcinoma. However, one week later the report came back from the laboratory as "inflammatory hyperplastic mass." Patient recovered and has been well ever since.

CASE 4. T. D., Italian, aged 38 years, referred by Dr. Eugene Talbot in November, 1928. Patient had a palpable mass in upper abdomen with marked pyloric obstruction symptoms. He had lost 30 pounds in weight. Dr. Talbot diagnosed condition as a granuloma about the site of a gastric ulcer. At operation a large, uncircumscribed mass was found involving all the pyloric end of the stomach, part of the duodenum and pancreas. An effort was made to remove the mass by a stomach resection. Only a part of the mass could be removed. The end of the duodenum was closed, the defect in the stomach sutured, and an anastomosis of stomach and jejunum

done. The patient died on the third day. Laboratory diagnosis was "inflammatory hyperplastic mass." I believe if a simple gastro-enterostomy had been done without an effort to remove the mass, which resembled cancer, the outcome in this case might have been different.

CASE 5. Mrs. T. R., aged 45 years, referred by Dr. E. D. Skeen, of Gary, Indiana. This patient had been operated upon 6 months previously by Dr. Skeen. At that time he found a large tumor mass of the omentum located chiefly in the left side of the abdomen on the level of the umbilicus. A section was taken from tumor mass for biopsy and the abdomen was then closed. It was reported as chronic inflammatory hyperplasia of the omentum. The mass remained palpable and as the patient was beginning to have obstruction symptoms, the author was called to Gary to re-operate. Upon opening the abdomen a thickened, nodular, and very firm omentum was found forming a definite tumor mass just above the left lower quadrant. It was fairly adherent to the small bowel from which it was finally freed. Below the omental mass, loops of the small intestine were found more or less closely bound together by thin, fibrinous, and fibrous bands of adhesions, the typical picture of a localized adhesive peritonitis. Three of these loops were so kinked as to be almost completely obstructed. The fibrous bands between these loops could not be torn away as could many of the fibrinous bands, but it was necessary to cut these. As completely as possible these adhesions were removed and then all of the thickened, granulomatous portion of the omentum was resected. The bowel itself showed no evidence of pathology other than the partial obstruction due to these external bands. The patient recovered but for 2 years was in poor health. A recent letter stated that she was now quite well.

CASE 6. C. B., white, male, aged 20 years. Patient entered St. Luke's Hospital on January 3, 1926, on the service of Dr. N. C. Gilbert. There was a history of loss of weight amounting to 15 pounds in the last 6 weeks, productive cough, lassitude, and pain in the left lower quadrant. Patient states that he was in good health until about 1 year ago when he began having attacks of tonsillitis. The last attack was 6 weeks ago and was very severe. On two occasions during the past year he had suffered pain in the left side of his abdomen, accompanied by vomiting, chills, and fever. There had been no diarrhœa or constipation. The diagnosis on admission to the hospital was perinephritic abscess.

Examination showed the left side of the abdomen was very tender with an irregular mass easily palpable just below the left costal margin. This mass seemed to extend backward and upward, it was impossible to say whether this mass originated from the kidney region or from the splenic flexure of the colon. The white blood count ranged from 14,000 to 18,000; the differential blood count was normal. Red blood count 4,200,000; hæmoglobin 78 per cent. The urine was negative on repeated examinations. Sputum examinations were negative. Temperature was 99.6 degrees, pulse 100, respirations 22.

A gastro-intestinal X-ray examination at this time showed a definite filling defect involving the proximal portion of the distal colon with a definite narrowing of the transverse colon. The pathology corresponded to the mass and seemed chiefly located about the splenic flexure area. Below this area were a number of small shadows which had the appearance of diverticula. Four different pre-operative diagnoses by four different consultants were made on this case, viz.: perinephritic abscess, diverticulitis of the colon, tuberculous granuloma similar to those seen about the cæcal area, and malignancy.

Patient was operated upon by the author on January 7, 1926. A left rectus incision 6 inches long was made and a mass about the size of a fist was found completely surrounding the splenic flexure of the colon. The mass was chiefly a firm, irregular tumor with areas of softening resembling ulceration. The omentum and greater curvature of the stomach were adherent to the mass above. The majority of the mass extended posterior to the colon. The pathologist was present at this operation and agreed with all the doctors who were standing about that the mass resembled a malignancy more than anything else. A section was taken and immediately examined by the frozen section method. The report was malignancy, most probably small round celled sarcoma. Meanwhile, a considerable portion of the tumor posterior to the colon had been removed. The remainder of the tumor so involved the bowel that resection would be necessary. When the frozen-section report came back, it was decided that a two-stage operation was most feasible and therefore a loop of the transverse colon was brought outside the abdominal wound preparatory to making a colostomy opening a few days later. The abdomen was then closed. The father of this boy was informed that his son had a malignant tumor and that the chances of recovery were very slight.

Four days later the following pathological report was submitted by Dr. Edwin F. Hirsch, pathologist at St. Luke's:

"Tissue from around splenic flexure of colon. These two pieces of fat and fibrous tissue markedly reddened are 7 by 4 by 1.3 centimeters and 3.5 by 2.5 by 1.5 centimeters. On each is a dark red granular surface, on the larger 4.5 by 3.5 centimeters, on the smaller 3.5 by 2 centimeters which is like granulation tissue. Cut across, there is considerable yellow fat and white tissue-like fibrous tissue. The frozen sections were regarded as containing (1) granulation tissue, and (2) possibly fibrosarcoma tissue. There are five more fragments of tissue like those already mentioned, together equal to a mass 6 by 5 by 2 centimeters. Microscopic examination shows that large portions of this tissue are dense hyalinized fibrous tissue and the portion corresponding to the reddened parts is a zone of œdematous granulation tissue containing many polymorphonuclear leucocytes. The changes in the granulation tissue are not

like tuberculosis. In the 85 sections of tissue examined from different levels and different blocks, there are no tissue changes, except those of a chronic inflammation and those associated with the healing of chronic granulation tissue. In no section is there tumor tissue. Diagnosis: chronic infective granulation tissue."

Two days following the operation, patient developed a very marked fæcal fistula. This persisted for 2 weeks. At the end of that time patient began passing fæcal material from the rectum normally. At the end of 3 weeks, the transverse colon was returned within the abdominal cavity. This was immediately followed by a recurrence of the fæcal fistula, which persisted for 10 days. Following this, patient again developed normal bowel movements. During his convalescence he showed a very marked loss of weight, loss of appetite, and periodic spells of nausea. He was in the hospital approximately 3 months. Patient now is in excellent health and has been for 4½ years (Fig. 4).

CASE 7. Mrs. M. J., aged 22 years, white, no children. Patient first entered St. Luke's Hospital on February 5, 1922, on the service of Dr. Eugene Carey, complaining of nausea, loss of appetite, constipation, and tenderness in right lower quadrant. In August, 1919, patient underwent an appendectomy. The attack of appendicitis had not been very severe, and no drainage had been necessary. Patient was free of symptoms until January 7, 1922, when, following the eating of a big dinner she complained of distress in the abdomen with nausea the following day. Since then she has had loss of appetite, nausea, nervousness, irritability, and constipation with occasional attacks of tenderness in the right lower quadrant. Other symptoms were negative. The menstrual history was normal. At this time physical examination revealed slight tenderness over the cæcum, colon definitely spastic. Gastro-intestinal X-ray examination at this time showed colon filling readily, with no defects or obstructions, tip of cæcum irregular with the constriction at the terminal of the ileum about one inch from the ileocæcal valve, some infiltration extending downward from the cæcum which is regular in outline and may be due to an abscess. A diagnosis of adhesions around the cæcum with probable abscess was made. The leucocyte count at this time was 7,800; red blood cells 4,370,000; hæmoglobin 81 per cent. Patient was discharged from the hospital after 3 days of observation.

Patient was referred to the author 10 days later by Dr. Eugene Carey and Dr. M. L. Blatt. At this time patient stated that her general physical condition had improved but she was still having the occasional attacks of distress in the right lower quadrant and the tenderness in this area was becoming more and more sensitive. There was a history of loss of weight and appetite for the past 3 or 4 months and at various times she had had fever in the afternoons. She was referred at this time because of a definitely outlined mass in the right lower quadrant. Examination of abdomen revealed tenderness and rigidity of her right lower quadrant. A mass about the size of a fist was palpable over McBurney's point. The mass was not movable. The liver was definitely palpable, the spleen not palpable. Temperature was 99.4 degrees, pulse 100, respirations 22. Leucocyte count was 16,000 on the first day, and 14,000 on the second. Red blood cells numbered 4,300,000. Hæmoglobin was 80 per cent. Vaginal examination showed the pelvic organs normal but the mass could be felt through the right vault. The general physical examination was otherwise negative.

On second day after admission, patient was operated upon, the incision being made over the appendiceal region. A large, well defined tumor mass about the size of an orange was found to involve the distal 2 inches of the ileum and the entire cæcum. The mass was adherent to the lateral, and posterior, parietal peritoneum and two areas of loops of small intestines were adherent to the mass. The pathologist of the hospital was present, as arrangements had been made for a frozen section if necessary. He agreed with the surgeon that the mass resembled a malignant growth. A small fragment was removed for frozen section examination. While this section was being made the tumor mass was rather easily freed from its adhesions and delivered from the abdomen with the involved portion of the bowel. Just as this was completed the pathologist reported that the frozen section showed carcinoma. Immediately resection of the tumor and involved bowel was performed, followed by a lateral anastomosis of the ileum and the ascending colon, near the hepatic flexure. The abdomen was then closed without drainage.

The patient's relatives were informed of the malignant nature of this tumor. Five days later the surgeon and attending physicians were called to the laboratory to examine the regularly prepared sections made from the specimen. These showed, instead of carcinoma, masses of inflammatory tissue. The microscopic slides showed considerable hyaline fibrous tissue in the intestinal wall at the head of the cæcum with focal areas of chronic inflammation. All the slides showed lymphoid tissue and large numbers of polymorphonuclear leucocytes. In several sections there were small groups of giant cells resembling mass cells which had resulted from some foreign body rather than from tuberculosis. The pathological report was infective granuloma of the cæcum. (This is the only one of my cases in which the pathologist has used the term "infective granuloma.")

In the head of the cæcum forming almost the center of the tumor-like mass was found a *linen pursestring suture* which undoubtedly formed the nucleus and cause of this infective granuloma. Patient made an excellent recovery and has been well ever since. Two years ago she gave birth to a baby and went through the ordeal without any complications (Fig. 5).

CASE 8. J. M., white, male, aged 53 years. Patient entered St. Luke's Hospital on July 30, 1926, com-

plaining of intermittent pain in the lower abdomen, knife-like in character, always starting under the right costal margin and moving downward to the pelvis across the left lower quadrant. This trouble was of 3 months' duration. Patient stated that he had been injured at work 4 months previously, at which time he sustained a skull fracture and other head injuries. He was in another hospital for 6 weeks and the records showed that he was unconscious for the first 2 weeks. For 2 weeks prior to his discharge from this hospital and for 10 weeks following his discharge, he had been troubled with these cramps. He had suffered a loss of appetite and had lost 110 pounds in weight. Because of these complaints, patient was sent to author for observation.

Physical examination revealed a poorly nourished white male, very thin, with slight tenderness in the umbilical region of the abdomen. No masses were palpable in the abdomen but the small spastic descending colon could easily be palpated. The bowel movements were irregular and suggestive of spastic colon. There was a large left scrotal hernia which had been present for years and which caused no trouble. There was slight œdema of both ankles. Physical examination was otherwise negative. Temperature was 98 degrees, pulse 80, respirations 20. Red blood count 4,550,000, white count 6,950, hæmoglobin 88 per cent, differential blood count normal. Urine was negative at all times. Wassermann negative. X-ray examination showed the gall bladder normal; the gastro-intestinal films presented no filling defects and no pathological change in the stomach, small or large intestines, except in the descending colon, which showed a spastic condition. A diagnosis of spastic colitis was made.

Patient was placed on small doses of tincture of belladonna and a very soft non-residue diet. At the end of 12 days he was discharged from the hospital relieved of his cramp-like pains and showing definite signs of improvement. He was instructed to continue the treatment described. Patient returned to the hospital 4 days later, however, with the same complaints. He was again placed under careful dietary regimen with tincture of belladonna and again showed improvement. He was again discharged on September 22, 1926.

On October 12, patient was brought to the hospital by his wife. He was very sick, the abdomen distended and very marked peristaltic waves were present. There was no marked tenderness nor rigidity. The abdomen was so distended that palpation of any tumor masses was impossible. There had been a marked loss of weight during the last 3 weeks. Constipation was present. With enemas small bowel movements were obtained and patient passed gas readily. Because of evidence of partial obstruction, another gastro-intestinal X-ray was contra-indicated. Temperature, pulse, and respirations were normal. The blood count remained normal. A diagnosis of carcinoma, possibly of the colon, with partial obstruction was made.

This patient was operated upon by the author on October 14. A midline incision 6 inches long was made. Immediately on opening the bowel a marked distention of the small intestine was observed. This distention ended at a small, hard, constricting mass in the ileum, and below this point the bowel was small and flat. This constricted area was about 2 inches in length. Opposite the constriction in the small bowel was a tear in the mesentery resembling a half moon and about 3 inches in diameter. Through this tear was a loop of small intestine which was not constricted and which was easily removed. A diagnosis was made on these findings of an inflammatory granuloma, the result of a slow necrosis followed by a reparative process. The necrosis of the bowel wall resulted undoubtedly from interference to its circulation by this tear in the mesentery.

A resection of the involved portion of the small bowel was done followed by end-to-end anastomosis; the abdomen was closed without drainage. Patient made an excellent recovery and was discharged on a Wednesday, 3 weeks later. At his request he was allowed to remain at the hospital until the following Sunday when he expected to go out of the city to convalesce. On Saturday night he developed severe pain and swelling in the left scrotal hernia. He was seen by an assistant who reduced the hernia and felt that the patient was in no danger. The author saw the patient early Sunday morning and because of definite induration in the hernial sac immediate operation was performed. A large amount of omentum was incarcerated in the hernia and had become strangulated. There was considerable accumulation of dark, serous material in the sac. Patient was very septic. He died 3 days later from this strangulation.

The pathological report made Dr. E. F. Hirsch, pathologist at St. Luke's Hospital, on the resected bowel follows: "The specimen is a segment of small bowel 3 centimeters long, continuous with a dilated portion 10 centimeters long. The mucosa of the first portion is pink-velvety, in transverse folds. Beginning abruptly is a pink, slightly depressed tissue that extends through the distal part of the second portion 8 centimeters and with these structures opened along the mesentery, this surface is fan-shaped, 9 centimeters wide. Beyond this region is pink, velvety, hyperæmic bowel lining in transverse folds. The fan-shaped region is made up of many close-set, but regular, small papillary elevations that vary in size from 0.5 to 1.5 centimeters. Cut across at this level, the mucosa is limited to the surface, about 1 millimeter thick, excepting the papillary folds. The width of normal bowel lining is about 5 centimeters at the lateral edges and 2 centimeters in the center. In the mesentery is a mass of fat tissue 8 centimeters long, about 6 centimeters wide, and 2.5 centimeters thick. It contains fibrous tissue and lymph glands, as large as 1.5 centimeters with pale gray tissue substance (see sketch). Microscopic examination shows that (A) the polypoid folds in the lining are vascular, chronic granulation tissue

in which the predominant elements are mononuclear cells, many like lymphocytes. Between the folds and in crevices are tissues densely infiltrated with polynuclear leucocytes. The muscular layer contains regions of chronic inflammation. The subperitoneal tissues are œdematous, and are changed by a chronic inflammation. The regional fat tissues contain mononuclear cells with a brown pigment like changed blood. (B) There is a hyperplasia of the lymphoid tissue and mononuclear cells in the lymph nodes of the mesentery. (C) This is a small bowel with an œdematous mucosa and submucosa. D and E resemble C. With all, there is a subperitoneal œdema and chronic inflammation. F, G, and H are essentially like A. Diagnosis: chronic inflammatory hyperplasia of small bowel with stenosis" (Figs. 6 and 7).

CASE 9. P. M., male, aged 40 years, was admitted to my service in St. Luke's Hospital in June, 1925. Ten days previously he was struck forcibly in the abdomen over the right rectus and just below the umbilicus by a heavy board rebounding from a circular saw when the saw struck a knot hole. Patient went home as he refused to enter a hospital. He was quite ill for several days but was not persuaded to go to the hospital until 10 days later. Examination on admission showed ecchymosis over the lower abdomen and extending down onto the perineum. There was slight rigidity and tenderness over the right rectus. Temperature and pulse were normal. White blood count 12,000. As patient seemed from his history to be improving, no operative interference was deemed necessary. A week later he was aliowed out of bed. The next morning he called our attention to a "lump" when he stood up. Examination showed a definite, true, traumatic hernia directly at the point where he was struck. This was operated upon the next day. On opening directly over the hernial mass the bulging peritoneal sac was exposed. On its inner surface was a tear and protruding through this tear was a granulomatous, thickened piece of omentum which was buried under the torn margin of the right rectus. It formed a mass about the size of half an egg and when it was freed and brought out into the wound a loop of small bowel was adherent to it. On freeing the bowel from the mass, a perforation in the bowel was exposed. This granuloma of the omentum had formed first as a protective agent over the site of perforation, had become mildly infected from the contents of the bowel, and had developed a granuloma which was truly a reparative process (Figs. 8 and 9). If the traumatic hernia had not developed we would perhaps never have known of this perforation.

CASE 10. R. D., male, aged 28 years, was injured by a heavy pulley striking him a severe blow over the right lower chest and right side of abdomen. He suffered fractures of the ninth and tenth ribs. He was admitted to Roslyn Hospital immediately after the accident. On the fourth day the author was called because patient was suffering excruciating pains in upper right abdomen. He seemed in great shock, respirations were 36, pulse 120 and thready, temperature 100 degrees, and white blood count 14,000. On examination dullness could be obtained over the right lower lung and a few fine râles with distant almost bronchial breath tones. The abdomen was distended and very tender, and rigidity was noticeable over all the right upper quadrant. His bowels had moved once in the last 24 hours but had not responded to enemas since then. The differential diagnosis between pneumonia and some abdominal condition was very difficult. I felt that all of the lung conditions could be explained by the fractured ribs and by the fixed diaphragm due to some intra-abdominal condition. The marked abdominal findings and the shock could not be explained by the lung findings. Diagnosis was tear of mesentery and hæmorrhage.

Immediate operation was performed. Free blood was found in the abdomen. A thickened mass could be felt in region of hepatic flexure. This mass was made up of granulomatous omentum and distended ascending colon. The omentum was freed and was found to be thickened until it was almost the size of an orange. A small tear was present in the mesentery and directly opposite this was almost a complete volvulus of the bowel. The colon was untwisted, the tear sutured, and the excessively thickened portion of the omentum removed.

SUMMARY AND CONCLUSIONS

1. Infective granulomata are far more frequent than the literature on this subject would lead one to believe.

2. The condition is directly due to a low grade infection causing an impairment to the circulation or to an impairment of the circulation followed by a low grade infection. In either case there is an inflammatory reaction characterized by a necrosis and a reparative process acting and reacting with a gradually increasing building up of an inflammatory mass until a granuloma reaching even the size of a cocoanut has formed. Occasionally the reparative process predominates early in the condition and one finds a constricting or stenosing granuloma.

3. Infections within the gastro-intestinal tract such as appendicitis or diverticulitis; ulcers either within the stomach or in the intestine; foreign bodies within the bowel lumen, in the wall of the bowel, or lying in the abdomen, such as pursestring sutures, lap pads, or instruments left in the abdomen, splinters penetrating into the abdomen, etc., may be the nucleus for the foundation of an infective granuloma. Trauma is a frequent

cause for the condition especially trauma which results in a tear of the mesentery, which allows foreign material to remain in the abdominal cavity or which may cause an undiagnosed and non-fatal perforation or laceration of the intestinal wall. Extraperitoneal inflammations may spread to, or involve, the gastro-intestinal tract in the granulomatous mass.

4. The diagnosis of carcinoma is most frequently made, when an infective granuloma exists. Many of our recovered cases of inoperable carcinoma of the gastro-intestinal tract have undoubtedly been granulomata. A more careful study of all cases of infective granuloma will enable an increasing number of correct pre-operative diagnoses to be made.

5. No tumor mass of the gastro-intestinal tract, considered at operation to be malignant and inoperable, should be abandoned without first removing a small section for biopsy. This will prevent a fatal prognosis being made of cancer when later the patient may recover because the condition was infective granuloma.

6. The etiology, the similarity in the chain of symptoms, the characteristic findings at operation, and the ability to make the diagnosis on histological study, warrant considering infective granuloma as a definite disease entity. In the presence of a tumor mass within the abdomen, the possibility of an infective granuloma should always be taken into consideration in making the diagnosis.

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REPLACEMENT LIPOMATOSIS OF THE KIDNEY[1]

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REPLACEMENT lipomatosis or fat replacement of the kidney parenchyma is of rare occurrence. The finding of fat in an organ in which it normally never is observed has aroused but very little interest on this continent. The European literature, while an old one, has brought forth many theoretical discussions concerning its unknown etiology and pathogenesis. Morgagni was the first to mention this condition but his case has been considered as doubtful (Hillman). Although Baader (1778) was the first to give definite mention to fatty changes in the kidney (Lacrampe-Loustan), Rayer in 1837 described the first well defined case when he noted "an interesting case of obliteration of the pelvis and all calyces except one which contains a calculus. The kidney is transformed into a fatty mass. The cortex is recognizable only in the upper part of the kidney where it has a layer of pale pinkish color. The pelvis and calyces are transformed into connective tissue strips distributed irregularly in a fatty mass, which has the shape of a kidney."

Godard (1859) made the first systematic review of the literature, reporting 12 personal and collected cases. According to Hillman, 4 of these were doubtful (Morgagni, Laennec, Cruveilhier, Petrequin) leaving 8 proved cases. In 1875, Ebstein reported a single case. Thinking that lipomata of the kidney were very rare, Lacrampe-Loustan (1881) wrote an exhaustive treatise noting extrarenal and intrarenal lipomata but failed to differentiate replacement lipomatosis from the latter. This led him to consider the cases of Baader, Barth, Bauchet, Houel, and Laboulene as intrarenal lipomata while in reality they were lipomatoses. A few years later, Rickards (1883) cited another case and collected 3 additional ones (Browne, Heath, Whipham). Isolated case reports have since appeared from time to time (Young—Kelly-Burnam, 1902; Morris, 1908; Furniss, 1915; Bacon and Le Count, 1928, 2 cases). The exhaustive study by Hillman (1924) has added 1 personal and 7 collected cases (Hartman, 2 cases; Griffon; Israel, 2 cases; Feodoroff; Grekov), while the more recent studies by Tiurikoff (1928) and Gimpelson (1929) have recorded 4 additional cases. A diligent search of the literature has revealed but 32 proved cases of lipomatosis of the kidney, and with the personal case herein reported, the total is brought to 33 cases. The American literature is most barren and it is for that reason that an additional case report and complete discussion have been made.

Male, aged 56 years, cigar dealer, came with the following complaints: (1) continuous dull pain in right kidney region; (2) burning on urination; (3) frequency; (4) slight chills and fever. The family history was irrelevant. The past history revealed that the patient had a chronic pulmonary tuberculosis about 35 years ago from which he had made a complete recovery.

The present illness began with a nocturia 2 to 3 years ago. No further history until 2 weeks ago when the patient began to complain of a very sharp pain in the right lumbar region which at first radiated into the right shoulder but later moved anteriorly and downward into the external genitalia. These colics would persist for 4 to 5 hours, leaving the patient with a continuous dull lumbar ache on the right side. Frequent urination and burning have been continuously present for the last 2 weeks as well as periods of slight chills and fever. There has also been a loss of appetite, headaches, and constipation.

The physical examination showed a fairly well nourished man, good color, and not appearing acutely ill. Temperature 99.5 degrees F.; pulse 72; respiration 20; weight 142 pounds. Blood pressure 140–90. Examination showed nothing remarkable.

Blood examination showed: hæmoglobin 89 per cent; red blood cells 4,280,000; white blood cells 9,800; polymorphonuclears 74 per cent; small lymphocytes 20 per cent; large lymphocytes 3 per cent; large mononuclears 3 per cent. Urine examination showed the urine to be cloudy; specific gravity 1,022; light amber in color; no albumin; no sugar. Microscopic examination showed numerous pus cells, occasional epithelial cells, no casts, gram negative bacilli. Intramuscular injection of phthalein was returned in first hour, 30 per cent, in second hour, 25 per cent, a total of 55 per cent. The blood Wassermann was negative. Blood non-protein nitrogen was

[1]Read before The Clinical Society of Genito-Urinary Surgeons, July, 1929, San Francisco.

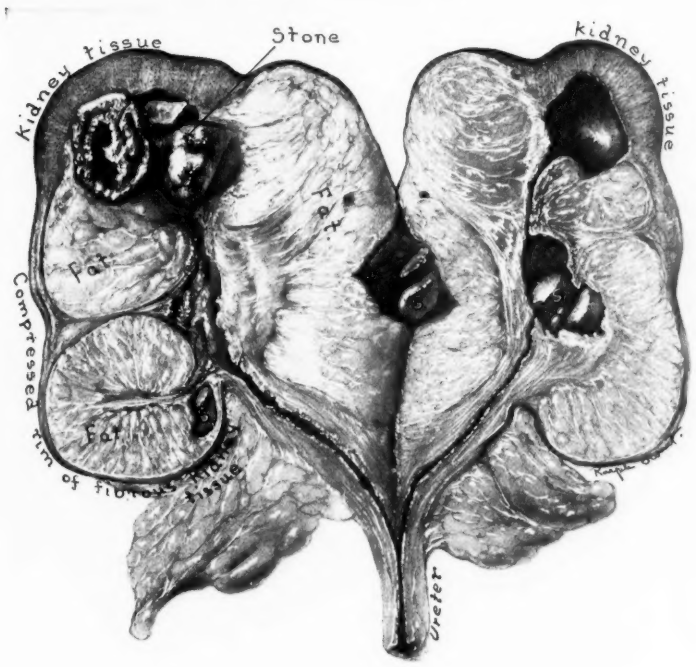


Fig. 1. Reproduced illustration of reported case of replacement lipomatosis of the kidney. Note relationship and morphology of the peripelvic, pelvic, and intrarenal adipose tissue as well as the calculi and remaining damaged renal tissue. The only apparent secreting renal parenchyma is in the upper pole behind a large calculus.

32 milligrams per 100 cubic centimeters of blood. Blood sugar was 89 milligrams per 100 cubic centimeters of blood.

Roentgen-ray examination of entire genito-urinary tract revealed 2 very large dense calculi in the right kidney, from 2 to 2½ centimeters in their greatest diameter, one being in the upper pole, one in the lower pole.

Cystoscopic examination. The bladder wall showed a mild diffuse cystitis; negative for stone, tumor, ulcer, etc. There was a slight redness about both ureteral orifices. The trigone and vesical neck appeared inflamed. Both ureters were easily catheterized to the kidneys. The right catheter immediately gave a drip of pure pus following which there was no further drainage during the examination. The urine from the right kidney showed numerous pus and red blood cells with no organisms in the stained smear. The culture grew a hæmolytic streptococcus. The left kidney urine showed numerous mononuclear cells and no organisms. The bladder urine contained some pus cells and an occasional epithelial cell; numerous gram positive cocci in chains and a few gram negative bacilli. Acid fast stains of all specimens were negative All cultures grew hæmolytic streptococci while the bladder urine gave in addition bacillus coli. Phthalein intrave nously appeared in 7½ minutes on the left side (the delayed appearance time being due to the left catheter ceasing to drain for several minutes); 25 per cent was returned in the first 15 minutes and 20 per cent in the second 15 minutes with no bladder leakage and no flow from the right side Pyelographic studies showed an incompletely filled and destroyed right kidney pelvis (Fig. 3).

Diagnosis: right calculous pyonephrosis.

Operation. A right intracapsular nephrectomy was done under nitrous oxide-oxygen anæsthesia. The kidney was found to be markedly adherent to all structures in the lumbar region especially to the posterior peritoneum and diaphragm. The perirenal fat was not increased in amount, but was very fibrous and tough. These factors markedly hindered the freeing of the kidney from the adjacent structures thus making the intracapsular procedure imperative.

Pathology. The kidney was an oval mass measuring 10.5 by 6.5 by 6.0 centimeters. One end and

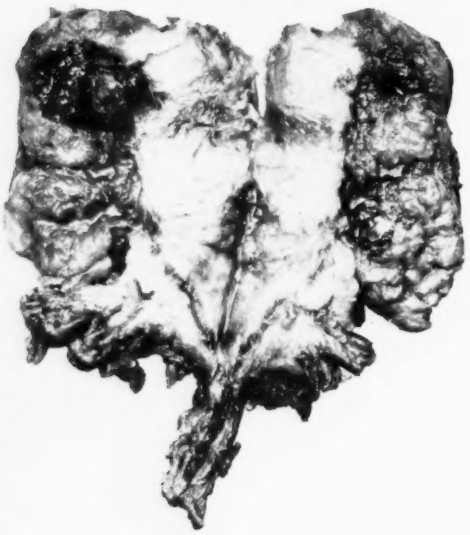


Fig. 2. Photograph of the kidney cut sagittally showing the replacement lipomatosis and renal calculi. The process extends throughout the entire pelvis and into each calyx.

part of one side consisted of reddish brown tissue resembling kidney cortex. Sharply marked off from this was fatty tissue which made up the other side and end of the mass. Section revealed only a shell of kidney tissue the remainder being fat (Figs. 1 and 2). The kidney pelvis, ureter, and renal vessels were embedded in the fat, the ureter projecting from the end which appeared to be entirely made up of fat. The calyces contained a number of brown, irregular calculi, the largest being a branching stone 3 centimeters long. The calyces extended from the shell down into the fat. The external surface of the fatty mass was definitely encapsulated in some places, while in other places the capsule had apparently been torn off. The surface was irregularly lobulated.

Microscopic examination showed the kidney substance to be atrophic and largely replaced by fibrous tissue. The walls of the calyces showed a marked inflammatory infiltration (Figs. 10, 11, and 12). There were numerous plasma cells, lymphoid cells, and a few leucocytes.

Summary: nephrolithiasis; chronic diffuse nephritis; atrophy of the kidney tissue; fatty mass of renal hilus which was apparently invading the kidney.

As the specimen was unusual, it was sent to Dr. W. Ophüls of the Department of Pathology of Leland Stanford University, who kindly examined it and made the following report:

The renal pelvis is filled with stones and is considerably shrunken. The wall is thick and fibrous. The kidney is almost totally destroyed and replaced by fibrous tissue. The defects produced by the shrinkage of the renal tissue and by the destruction of some of the calyces are filled with fatty tissue. Sections of the ureter and of the renal pelvis show marked fibrosis of the wall which on the inside show a layer of granulation tissue. In places the latter is covered by a thin stratified epithelium which resembles stratified squamous epithelium. The slight metaplastic change of the epithelium of the renal pelvis is nothing unusual (Fig. 9). The renal tissue is almost entirely replaced by very cellular fibrous tissue in which there are multiple small abscesses. There are few remnants of glomeruli and tubules, marked endarteritis of the smaller arteries (Figs. 5 to 12).

Summary: calculi, renal; pyonephrosis with shrinkage and fatty replacement of kidney tissue.

Patient made an uneventful convalescence and is still living, the operation having been performed over 3 years ago. He still has some residual cystitis. His general condition is fair, with some complaints of gastro-intestinal disturbances.

This case is definitely a lipomatosis or fat replacement of the kidney, associated with calculous disease. It is typical and similar in all characteristics to the cases reported in the literature. The specimen revealed a large amount of pelvic and peripelvic fat which no doubt must have been the origin of the fat filling the kidney, thereby adding support to the theory that the invasive proliferation of fat begins in the pelvic and peripelvic adipose tissue and follows the destruction (atrophy or compression) of the kidney parenchyma. The rim of kidney tissue surrounding the fibrous fatty mass presents a picture of an overwhelming inflammatory and infectious process with the surviving atrophied elements such as hyalinized and dilated tubules and sclerosed glomeruli and blood vessels, a picture not infrequently found in an advanced hydronephrosis or pyonephrosis. The fat in the kidney was of a tough fibrous variety which is characteristic of replacement lipomatosis of the kidney. The clinical picture was that of a markedly infected calculous kidney disease while the associated fatty condition remained undiagnosed until operation.

PATHOGENESIS

By replacement lipomatosis or fat transformation of the kidney is meant a substitution of the renal parenchyma by true adipose tissue. It has been variously designated in the

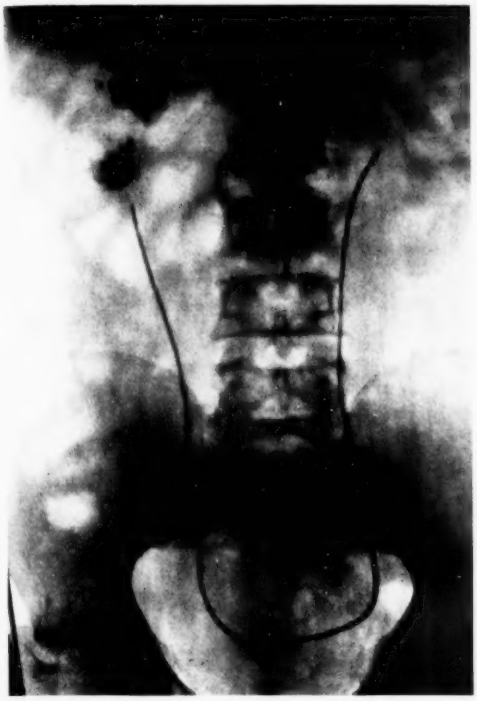


Fig. 3. Pyelogram showing a small amount of the sodium iodide in the pelvis proper and a large calculus in the upper pole. Since the pelvis and calyces were filled with adipose tissue, a complete pyelogram was not possible.

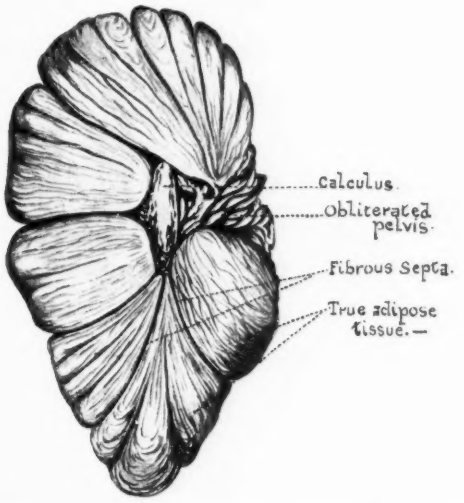
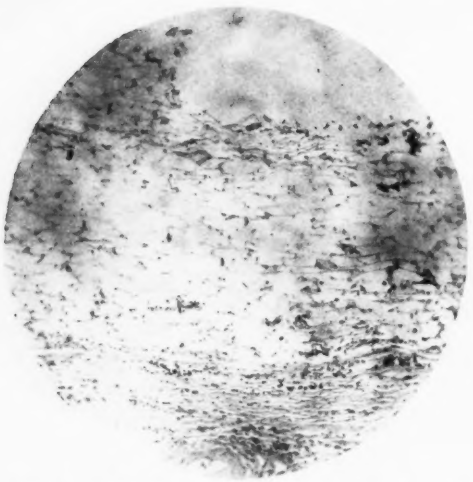


Fig. 4. Reproduced illustration of Rickard's case of replacement lipomatosis. Note the resemblance to the reported case.

literature as lipomatous nephritis, lipomatous paranephritis, lipoma diffusum renis, substitutio renis adiposa, lipomatosis renis, fatty transformation of the kidney, fat replacement of the kidney, and fatty degeneration of the kidney. These terms are more descriptive of the latter stages of this pathologico-anatomical process, in which the entire kidney parenchyma may have disappeared. In the earlier stages where the changes are yet to occur in the hilus and polar regions of the kidney, the term "lipomatous paranephritis" has been considered more descriptive by some observers. The process has not been satisfactorily explained. Most dissertations present only a limited discussion, classifying it with the paranephritides. The fat may either surround the kidney or limit itself to individual areas, usually at the hilus or polar regions of the kidney. It may even involve the ureter at times, assuming the dimensions of a "colossal fat tumor." The fat substitution usually parallels an atrophying renal process—renal atrophy and fat hyperplasia—a fat tissue accumulation which may push into all parts of the kidney pelvis.

If the process has markedly progressed there may remain only a rim of sclerosed atrophic renal tissue. This has led the French authors to designate the process as "substituto renis adiposa" (Hillman). The pelvis and calyces are entirely obliterated by fibrous fatty tissue. The contour and shape of the kidney are more or less maintained. Cross section of such a kidney usually gives the appearance of a fatty mass with the pelvis and calyces divided by connective tissue strips and septa (Figs. 1, 2, and 4). The cortex can be noted as a thin rim, forming a capsule about the fatty mass. In addition there is the true fibrous capsule of the kidney externally. The fatty mass is in direct association with that of the pelvis, hilus, and peripelvic tissues so that it may appear as one connected fatty mass. This picture is well illustrated by the reported case. Usually calculi are found in either the pelvic fatty mass or in the calyces; occasionally there is evidence of a

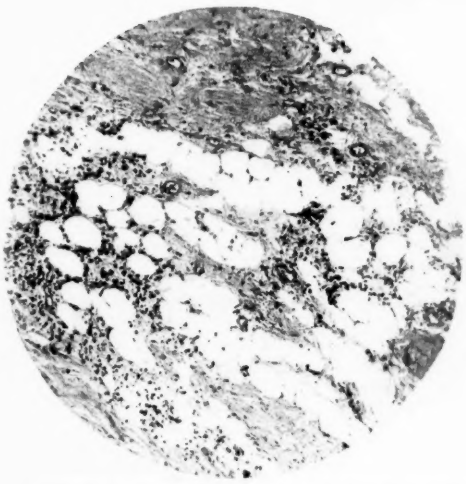


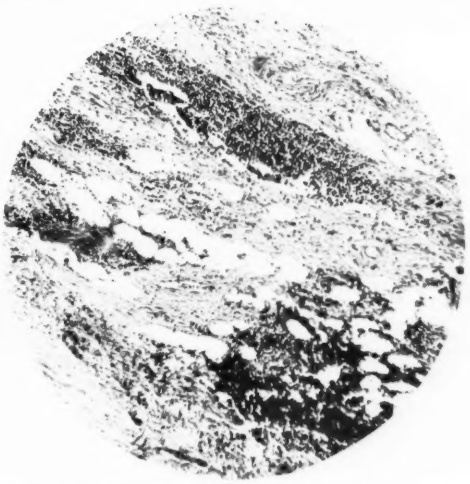
Figs. 5 and 6. Photomicrographs (high power) showing the structure of the adipose tissue found in the pelvis and calyces. Note the rather sharply defined border of the fibrous renal parenchyma. Figure 5 shows a large collection of small round cells between the adipose tissue and the fibrous renal parenchyma to the degree of abscess formation.

pyonephrotic condition without calculi. Microscopically the picture is that of true adipose tissue and bears no direct metaplastic relationship to the renal tissue or neoplastic fatty tumors (Figs. 5 and 6). Areas have been noted where it may appear that the fat has invasive powers by finding evidences of vacuolization in the atrophic kidney parenchyma. Laboulene (Lacrampe-Loustan) has described a case in which the cortical and tubular areas showed evidence of invasion and destruction by many fat deposits. This was noted to some extent in the sections of the reported case (Figs. 7 and 8).

Some interesting and speculative theories have arisen as to the source of the fatty tissue and the reason for its penetration into the kidney. Whatever the source of the fat, it probably is not from a degeneration or metaplasia of the kidney parenchyma, but from an external source. Todd and Bowman (1853) (Lacrampe-Loustan) noted that fatty transformation of the kidney could follow atrophy of the kidney, chronic pyelonephritis from calculous disease or simple inflammation, with an abundant accumulation of fat in the perirenal tissues frequently encroaching on the kidney proper. Houel (1857) as well as Cruveilhier (Lacrampe-Loustan) were of the opinion that the renal substance itself is not invaded by the fat, but more often the kidney atrophies and shrinks but always remains intact. Lacrampe-Loustan thought the fatty changes in the kidney to be due to lithiasis. Rickards believes the fat to be developed to fill up space created by the destruction of the kidney parenchyma and that the process is a physiological one "to compensate and prevent a vacuum"; that the origin of the fat may be from one of three sources: (1) hypertrophy of the circumrenal fat pushing its way into the kidney through the hilus; (2) hypertrophy of the fat normally found in small amounts in the interior of the kidney between the apices of the pyramids; (3) absorption of fat by the cells forming the stroma of the organ.

Matsuoka has stated that lipomatosis or abnormal increase in adipose tissue is pathological and will cause atrophy and degeneration of the organ wherein situated. He has accordingly divided lipomatosis into two groups: first, where an invasion of the adipose cells from the surrounding into the affected tissue plays a relatively important rôle and there is a proliferation of fat cells in the interstitium of the affected tissues; second, the organ affected shows primary atrophy of the parenchyma, with fibrosis and later lipomatosis occurring as the fibrous connective tissue





Figs. 7 and 8. Photomicrographs (high power) showing the invasion in some areas of the destroyed and fibrous rena parenchyma by the fatty tissue and chronic inflammatory elements.

cells become infiltrated with fat droplets. The author states that there is no invasion as in the first group. The process is described as replacement lipomatosis following a replacement fibrosis. This type of lipomatosis occurs in patients with wasting diseases. In referring to the kidneys, Matsuoka states that they are exceptions to the first group since fat cells do not pass through the capsule into the substance of the kidney nor do they develop in the interstitium. He gives as his reason that the firm kidney capsule with its dense areolar tissue and numerous elastic fibers protects the kidney from invasion by the capsule fat. As to the second group, Matsuoka states that lipomatosis of the kidney consists entirely in an overgrowth of perirenal fat. It is not a growth of fat cells following fibrosis, but associated with fibrosis. With this fibrosis of the kidney, there occurs also an increase in the perirenal fat. The author has failed to comprehend the hilus of the kidney as a portal of entry for the fat. We shall later revert back to these observations in offering our theory.

Under normal physiological conditions there is only one example of fat replacement in a glandular organ, namely the thymus. It has been found that gradually the specific organ tissue disappears beginning first with the cortical layer, and is replaced by fat and connective tissue. This occurs by penetration of the adjacent fatty tissue between the lobules of the gland, finally resulting in the thymus becoming a globule of fatty tissue by the age of

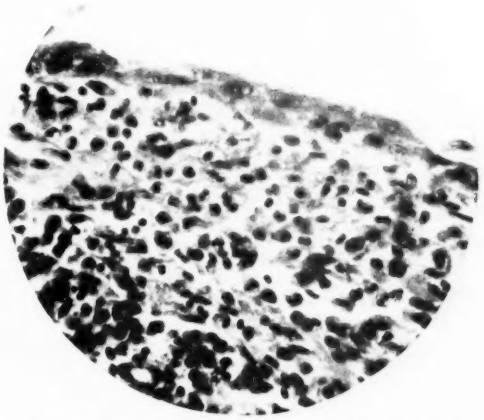


Fig. 9. Photomicrograph (high power) showing a section where the mucous membrane of the renal pelvis has changed to a thin stratified epithelium resembling stratified squamous epithelium. Beneath this is seen the typical picture of chronic inflammation. This slight metaplastic change is nothing unusual and therefore of no significance.

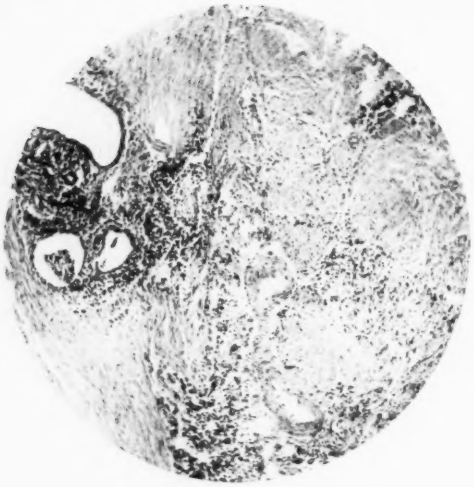


Fig. 10.

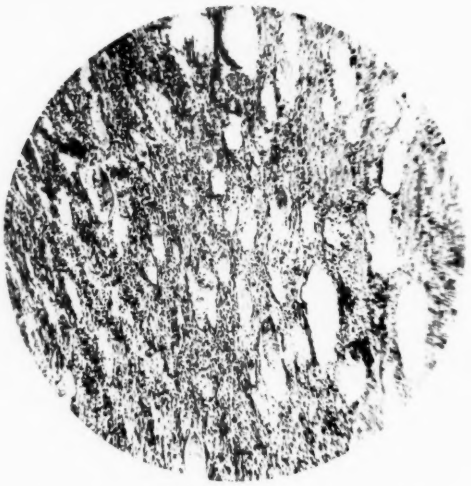


Fig. 11.

Figs. 10, 11, and 12. Photomicrographs (low and high power) from the thinned out area of the remaining renal parenchyma showing the extensive destruction by chronic inflammation and pyonephrosis.

Fig. 12.

15 years. In various pathological conditions, fatty tissue may develop in the heart and skeletal muscles. This does not include fat deposition in the epicardium, but the actual penetration of fatty tissue through the connective tissue between the fibers in nutritional disorders of the muscles. A review of the older literature has shown that Rayer, Cruveilhier, and Rokitansky considered the hypertrophy of fatty tissue as taking place in certain chronic diseases of the kidney, but fatty substitution was noticed only in cases of well defined atrophy of the parenchymal tissue caused usually by a chronic calculous pyelitis or pyonephrosis. There follows proportionally to the atrophy of the parenchyma, a proliferation of the fatty tissue of the hilus between the pelvis and calyces into the kidney, but more rarely. Rokitansky stated that in a continuous moderate inflammation of the kidney, usually caused by calculi, there could occur a proliferation of the fatty tissue which might accumulate around the kidney and lead to its atrophy; the fatty tissue gets its impulse for proliferation from the need for replacing the atrophied organ (hyperplasia *ex vacuo*) that is, by what he terms "a biological inertia." Rosenstein (Hillman) accepting the secondary character of the fat proliferation still believed that in some cases the transformation of the gland tissue into fat might be independent of the atrophy. Klebs, however, doubted that it would be possible for the kidney to be compressed by hyperplastic fat tissue. Fedoroff thought that in his case the proliferation of the fibro-fatty mass had its beginning in the pelvic fatty cellular tissue, and that the atrophy of

the kidney might be considered as the primary force for the proliferation of the pelvic fat. Israel explained replacement lipomatosis as an irritative hyperplasia of the fat tissue of the fatty capsule of the kidney; while this hyperplasia might be limited to certain parts, it usually involved the entire fatty capsule. The basis for this irritative hyperplasia could be any chronic inflammatory process in the kidney that leads to destruction of the kidney parenchyma and the formation of new connective tissue, nephrolithiasis being the usual one. As a rule in cases with infected renal calculi, the perirenal tissues are nearly always affected. With an initial adhesive fibrotic process there may ensue a change to the fibro-adipose tissue. This has been designated as a "lipomatous paranephritis." Fatty substitution may then result only if the kidney has been destroyed. In such instances there is a growth of adipose tissue which begins around the capsule and then pushes its way through the hilus. This process may not terminate with just substituting for the disappearing parenchyma, but may call forth a hyperplastic process which in some instances may be confused with a neoplasia. Gimpelson has stated that this pathologico-anatomical process belongs to the "hyperplasia *ex vacuo*," similar to the substitutionary growth of fat following this disappearance of tissue in a parenchymal organ (fat substitution in an atrophic thyroid; fatty growth in pathological lymph glands). The fatty growth *ex vacuo* he considers biologically as an effort of the organism to maintain its weight balance.

In his exhaustive treatise Hillman explains the origin of the fat as follows: (1) the fatty tissue of the adipose capsule in spreading compresses the kidney leading to its atrophy and replaces it; at the same time the hilus tissues penetrate into the kidney; (2) primary atrophy of the kidney follows as a consequent hyperplasia of the fatty tissues; and (3) the fatty tissue replacing the original tissue is developed through metaplasia of the connective tissue of the kidney while a process of atrophy takes place in the latter. The third theory, while being theoretically possible, in reality has little foundation; there is so little connective tissue present in the kidney that there can hardly be any active part attributed to it. This leaves the second theory as the most plausible and as that most corroborated by the case reports in literature. Hillman believes that if the process of the spreading fatty tissue were an active one, then traces of renal tissue could be found between the lobules; that therefore the fatty replacement is of a secondary nature and is caused by atrophy of the kidney. He feels that while the hilus fat is unable to initiate atrophy of the renal parenchyma it may in those cases in which the process of atrophy is already present, and the fatty tissue is thereby given an impulse to grow and is able to penetrate into the kidney along the vessels, so that it subsequently becomes one of the factors in producing atrophy. For this reason Hillman believes the term "substituto renis adiposa" as the most logical and descriptive.

While the theories concerning the pathogenesis of replacement lipomatosis may appear to be numerous they can be placed in two essential groups. A minority number of authors consider the primary growth to be from the fatty capsule while coincidentally the hilus fat forces its way into the kidney leading secondarily to an atrophy. There is no overwhelming evidence to support this view. The second or majority group of observers hold that the fat substitution is of a secondary character, considering the atrophying process of primary importance. To support the latter view it has been pointed out that at times retroperitoneal lipomata assume huge proportions, surrounding and pressing the kidney on all sides and yet cause no destruction nor atrophy of the kidney parenchyma. If the fatty growth were of a primary nature, histological examination should reveal traces of kidney tissue, which has never been the case. Between the fat tissue and the remaining atrophic kidney tissue there is usually a sharp boundary.

Careful study of my case has led me to believe the calculous disease of the kidney to be the primary and initial factor in replacement lipomatosis of the kidney. Analysis of the 33 collected cases revealed calculous disease in 79 per cent (26 cases out of 33). Of 3 bilateral cases of replacement lipomatosis, 2 had bilateral renal or ureteral calculi. Combined with an infection there results destruction of the

TABLE I.—COLLECTED CASES OF REPLACEMENT LIPOMATOSIS OF THE KIDNEY

No.	Name, Date	Sex, Age	Side	Calculosis	Anatomy
1	Baader 1778	F.	Right	Ureteral calculus with suppurative pyelonephritis	Autopsy. Fatty kidney found. Center filled with pus
2	Barth 1835			Stones at ureteropelvic junction	Autopsy. Disappearance of cortical substances with invasion of fatty tissue
3	Bauchet 1853	M.	Right	Right ureteral stone. Stones in left kidney	Autopsy. Right kidney replaced by a complete fatty mass
4	Browne 1861	M. 11	Left	Calculus found	Autopsy. Kidney composed of dense adipose tissue
5	Dupuytren	M. 18	Right	Multiple calculi present	Autopsy. Kidney almost entirely changed to fat
6	Ebstein 1875	F.	Left	No stone mentioned	Autopsy. Entire kidney converted into fatty tissue
7	Fedoroff 1893	F. 45	Right	Stones present	Autopsy. Kidney replaced by a fibro-adipose tumor
8	Furniss 1915	F. 67	Left	Calculus present	Operation. Kidney converted into a hard, tough, fatty mass
9	Gimpelson 1929	F. 54	Right	Calculi present	Mass of adipose tissue covered by a thin layer of renal tissue
10	Gimpelson 1929	F. 44	Right	Calculus present	Autopsy. Kidney all fat with pyonephrotic cavities. Practically no renal tissue visible
11	Godard 1859	M. 58	Left	Stone present	Autopsy. Suicide. Most of kidney changed to a fatty mass
12	Griffon 1886	M. 65	Bilateral	Stones in both kidneys	Autopsy. Right kidney a fatty mass. Left kidney atrophied with fat and pus predominating
13	Hartmann 1885	M. 30	Right	Large renal calculus	Autopsy. Kidney showed fatty tissue with remnants of parenchyma
14	Hartmann 1885	M. 39	Left	Large renal calculus	Autopsy. Fatty mass penetrating into kidney
15	Heath 1858		Left	No stone mentioned	Autopsy. Kidney chiefly adipose tissue
16	Hillman 1924	F. 56	Left	Multiple calculi	Operation. Kidney composed of fatty tissue containing remnants of parenchyma
17	Hillman (Grekov) 1924	F. 51	Left	Multiple calculi	Operation. Fatty degeneration of kidney
18	Houel 1857			No mention of calculi	Autopsy. Kidney almost entirely transformed into fat
19	Huette 1848	M. 60	Right	Multiple small calculi	Autopsy. Kidney mostly fat with traces of parenchyma
20	Israel 1901	F.	Left	Stones present	Operation. Complete fatty degeneration of kidney
21	Israel 1901	F. 56	Left	No stones	Operation. Kidney a conglomeration of fat
22	Kutzmann 1931	M. 56	Right	Multiple calculi	Operation. Entire kidney transformed into fatty mass except small area at upper pole
23	Laboulene			No mention of calculi	Autopsy. Kidney parenchyma invaded and destroyed by fatty tissue
24	Le Count and Bacon 1928	F. 39	Right	Multiple calculi	Operation. Most of renal parenchyma replaced by fat
25	Le Count and Bacon 1928	M. 54	Left	Multiple calculi	Operation. Most of renal parenchyma replaced by fat
26	Morris 1908	F. 54	Left	Calculus present	Operation. Fatty mass occupied entire pelvis and part of parenchyma
27	Rickards 1883	M. 24	Bilateral	Calculi in both kidneys	Autopsy. Both kidneys transformed into fat
28	Rayer 1837			Stones present	Autopsy. Kidney practically transformed into fat
29	Rayer 1837	F. 45	Bilateral	Stones not mentioned	Autopsy. Both kidneys transformed into fat
30	Tiurikoff 1928	F. 22	Right	Calculus present	Cross section of the kidney appeared like a solid fatty mass
31	Whipham 1867	M. 40	Right	No stone mentioned	Autopsy. Kidney almost entirely replaced by fat
32	Wischnewski (Gimpelson) 1929	F. 54	Left	Calculi present	Picture of fatty tissue with rests of kidney tissue enclosed
33	Young (Kelly-Burnam) 1902			Calculus present	Renal parenchyma largely replaced by fatty tissue

TABLE II.—DOUBTFUL CASES OF REPLACEMENT LIPOMATOSIS OF THE KIDNEY—INSUFFICIENT DATA

No.	Name, Date	Sex, Age	Side	Calculosis	Anatomy
1	Cruveilhier 1856				Autopsy. Kidney metamorphosed into fat. Considered doubtful by Hillman
2	Israel (Case III) 1901			Large calculus in kidney pelvis	Moderate increase of the hilus fat around pelvis. Classified as a local proliferation of fat, hence, doubtful case
3	Laennec				Cited by Hillman as a doubtful case. No data
4	Morgagni				Cited by Hillman as a doubtful case. No data
5	Pascal 1833				Autopsy. Kidney stripped of its capsule, exuded fat and floated on water. Insufficient data makes case doubtful
6	Petrequin 1836				Autopsy. Fatty transformation of kidney accompanied by a hydronephrosis. Considered doubtful by Hillman and Lacrampe-Loustan

kidney pelvis and parenchyma until we get the familiar picture of a pyonephrosis. If the fat be removed from the dilated pelvis and calyces the customary outline of an infected hydronephrosis or pyonephrosis can be recognized. This pathological process will compress and destroy by infection the renal parenchyma as is seen in the microscopic picture. It has often been noted that the peripelvic fat shows a hyperplastic tendency in the presence of long standing infections. Tuberculosis is a notable example. The presence of calculi and the chronicity of the infection may therefore result in giving a proliferative and invasive power to the already hyperplastic peripelvic fat about the renal hilus resulting in an invasion around the renal vessels. Resorting to the grouping of lipomatosis as offered by Matsuoka, replacement lipomatosis may then be explained by utilizing the criteria of both groups. First, there may occur the proliferation of adipose tissue externally with invasion through the hilus and renal vessels, a fact not comprehended by Matsuoka; second, with a destruction of the renal parenchyma by the infectious calculous disease, much fibrosis occurs in the remaining renal tissue and with this there may be a concomitant lipomatosis as the fibrous connective tissue cells become infiltrated with fat droplets. Microscopic examination of various sections has shown small accumulations of fat cells in the fibrous tissue (Figs. 7 and 8). It is not beyond reason to believe that fat may have invasive powers as has already been noted in some lipomata. With the invasion of the fatty tissue a third destructive factor is added to the already present calculosis and infection, all 3 of which may continue to destroy or atrophy the already damaged parenchyma. That a calculus may act as a barrier against these destructive factors is well illustrated in the upper pole of the reported case in which the only secreting kidney tissue remaining was that behind the calculus. If replacement lipomatosis be a defensive process why does it occur so rarely and why should pyonephrosis, which is a more destructive process, be the usual outcome? I am unable to answer the question at this time.

Replacement lipomatosis of the kidney is to be distinguished pathologically from fatty tumors in the kidney region. Some observers have either considered or confused replacement lipomatosis with fat tumors of the kidney. True renal lipomata are rather infrequent in occurrence, usually small in size, yellowish in color, found as encapsulated nodules, possessing a fibrous capsule, in the cortical layer directly beneath the fibrous capsule. They result from rests of fatty tissue which have become included in the kidney during embryonal life. Replacement lipomatosis possesses none of these characteristics. Only as a possible simulation between the two, Tuffier states that the pyelonephritides with a chronic course call forth a significant fatty hypertrophy of the fatty capsule, a true perirenal lipomatosis remotely resembling a renal growth. Replacement lipomatosis is not a neoplasm, clinically, anatomically, or pathologically.

There are also the fat tumors of the fatty capsule of the kidney or, more exactly, the

lipomata developed from the fatty tissue found between the fibrous and fatty capsules of the kidney. These tumors are often classified with the retroperitoneal and perirenal lipomata. A third condition to be differentiated is the so-called "myelin kidney" in which in rare instances a large amount of doubly refracting lipoid has been laid down in linear deposits which may be seen in the cortex.

CLINICAL STUDY

There are no pathognomonic signs nor symptoms for the clinical recognition of replacement lipomatosis of the kidney. It can be diagnosed only from surgically removed or autopsy kidneys. The clinical picture is dominated by the associated urinary calculosis and infection. Prior to the present century all cases were found at autopsy (19 cases). In 1901, Israel for the first time noted replacement lipomatosis in a surgically removed kidney, as has been done in nearly all cases since (14 cases).

The condition is very rare, 33 proved cases (Table I) as well as 9 additional doubtful cases (Table II) having been collected. A study of these cases has revealed the fact that all presented urinary infection and that 79 per cent (26 out of 33 cases) were associated with renal or ureteral calculi. Of the latter, 3 cases were bilateral (Bauchet, Griffon, Rickards). Replacement lipomatosis of the kidney has been found almost equally distributed as to sides: right, 12; left, 13; bilateral, 3 (Rayer. Rickards, Griffon); not stated, 5. It should be noted that 2 of the 3 bilateral cases also were associated with bilateral calculi, which may be of some significance in considering their pathogenesis. Distribution of the cases among sexes was: 12 males, 15 females, and 6 not stated. The age distribution is a wide one, the youngest case being 11 years (Browne) and the oldest 67 years (Furniss). Occurrence as to decades is as follows:

Years	Cases	Years	Cases
0 to 10	0	41 to 50	3
11 to 20	2	51 to 60	10
21 to 30	3	Over 61	2
31 to 40	3	Not stated	10

Treatment of replacement lipomatosis *per se* cannot be carried out since the condition is not recognizable clinically. Judgment must, therefore, be governed by the associated calculous or infectious condition. Hillman has stated that were it possible to recognize the fatty replacement *in vivo* and differentiate it from pyonephrosis, in cases with an obliterated ureter and free from pus, fear for infection of the opposite kidney would be obviated and nephrectomy would therefore not need to be carried out on the affected kidney. Since this is not possible, and furthermore since most of these kidneys are infected, painful and functionless, there being no contra-indications, nephrectomy should be the treatment of choice. Surgically these cases are apt to be difficult because of a great amount of perirenal adhesions and paranephritis caused by a long standing chronic renal pathological process.

SUMMARY

1. Replacement lipomatosis of the kidney is a rare disease.

2. Thirty-three cases have been collected inclusive of the personal case herein reported. Nine additional cases were found but these are classified as doubtful.

3. Replacement lipomatosis of the kidney is always associated with a kidney infection, usually intense and with calculous disease in 79 per cent of cases.

4. Replacement lipomatosis of the kidney has a nearly equal distribution as to sex and side involved.

5. Clinically there are no pathognomonic signs nor symptoms. The earlier cases were found at autopsy, while recent specimens have been found in surgically removed kidneys.

6. The pathogenesis is on a theoretical basis of replacement. The process is probably one of invasion by the perirenal, peripelvic, and hilus fat along the large vessels through the renal hilus, following a destruction of the renal parenchyma by calculosis and infection.

7. Treatment is directed to the associated condition and usually is nephrectomy, since these kidneys are painful, badly infected, and functionless.

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ACUTE INTESTINAL OBSTRUCTION[1]

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THERE is probably no condition which causes a surgeon more concern than ileus. The symptoms of intestinal obstruction are usually quite definite but vary considerably according to the location of the obstruction, that is, whether it is relatively high or relatively low in the intestinal tract and the degree of interference with the blood supply of the affected gut. As is well known, mere obstruction of the intestinal tract in the absence of interference with the blood supply to the intestines produces, aside from obstipation, relatively few symptoms and signs in clinical cases. Murphy and Brooks, Nesbitt, the Dragstedts and their co-workers, Gatch, Trussler and Ayres, Foster and Hausler, Hartwell and Hoguet, Howell, Wilkie, and Sugito have emphasized the relative absence of signs in experimental animals under similar conditions. The symptoms and signs are more pronounced the higher the obstruction in the intestinal tract. Both clinically and experimentally, symptoms and signs are most marked in those cases in which the obstruction is in the duodenum and at a point just below the openings of the pancreatic and common bile ducts. Brooks and his co-workers and the Dragstedts and their co-workers have shown that in experimental "closed loop" obstructions the shorter the loop, the more rapid is the intoxication. Recently Owings, McIntosh, Stone, and Weinberg have shown that following intestinal obstruction there is a decided increase in intra-intestinal pressure, the pressure varying with the amount of peristaltic activity; the peristaltic activity being greatest in the uppermost portion of the intestinal tract. These observers, however, found that the maximum pressures at different levels in animals with high and low obstruction do not show great differences. Morton, on the other hand, repeating the experiments of Owings, McIntosh, Stone, and Weinberg, found that there was considerable difference between the amount of pressure within a loop of duodenum and one of lower ileum. Whereas the normal intra-intestinal pressure varies from 2 to 4 centimeters of water he found that after obstruction had been present for 24 hours the pressure within the duodenum and ileum had increased to from 28 to 36 and to from 4.5 to 5 centimeters of water, respectively. This excess in pressure of the upper intestinal tract over that of the lower results from the marked secretion of the duodenal mucosa, as well as from the presence of the biliary and pancreatic secretions, in contrast to the absorptive mucosa which is found in the lower part of the intestinal tract. Morton found that the duodenum secreted from 5 to 10 times as much fluid as the ileum in a given period of time. He believes that obstructions low in the intestinal tract are similar to those with long closed loops, whereas obstructions located at a higher level are comparable to short closed loops.

Dragstedt, Lang, and Millet have shown that there is considerable variation in the intramural blood supply of the various parts of the intestine, and as a result of this anatomical variation, pressure within the gut exerts varying influence on the blood supply of the gut. They found that the flow in the veins of the wall of the intestine ceased when the intra-intestinal pressure within the duodenum, jejunum, ileum, and colon attained a height of 35 to 45, 55 to 65 and 95 millimeters of mercury, respectively. This difference, they believe, is due to variation in the length of the intramural blood vessels. They found that if a cross section of the bowel be represented by the face of a clock with the mesenteric attachment at six o'clock, the vasa recti pierce the muscularis in the case of the duodenum at approximately five and seven o'clock, in case of the jejunum and ileum at five and three o'clock, and in case of the colon at two and ten o'clock. In the duodenum any increase in intra-intestinal pressure exerts considerable pressure on the vessels which lie between the mucosa and the muscularis. In

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the colon, however, in which the greater portion of the vessel lies outside the muscularis, an increase in intra-intestinal tone exerts relatively little effect on the blood supply. Morton and Sullivan also found a richer blood supply in the lower duodenum than in the ileum. The importance of intra-intestinal pressure in intestinal obstruction has recently been shown by Raine and Perry, who found that in experimentally produced obstruction of the ileum in rabbits, the administration of rather large amounts of water at frequent intervals caused no evident increase in intra-intestinal pressure, probably because of the absorption of the fluid. If, however, liquid abolene were administered, the animal died relatively quickly and showed the same blood changes as those shown by animals with high jejunal obstruction. It can thus be seen that aside from obstipation and certain changes in the blood, which will be mentioned subsequently, the symptoms in intestinal obstruction are not marked unless there is some interference with the blood supply. This decrease in the blood supply, however, may be the result of compression of the intramural vessels produced by an increase in the intra-intestinal pressure and the peculiar susceptibility of the vessels in the upper part of the intestinal tract to compression. The increased pressure in high obstructions is usually the result of both excessive secretion and diminished absorption within the affected part of the gut.

As a result of simple obstruction in the absence of interference with the blood supply to the intestine, dehydration and hypochloræmia occur as a result of the loss of fluids and hydrochloric acid in the vomitus. Hartwell and Hoguet, in 1912, believing that the symptoms in acute intestinal obstruction were due to dehydration, found that animals with obstruction could be kept alive over long periods of time by the administration of large amounts of normal saline solution. These observations were corroborated by Draper. The true value of the administration of the normal saline solution was not appreciated until Haden and Orr found that rather typical blood changes occurred in intestinal obstruction, namely, a decrease in the blood chlorides and a rise in the carbon dioxide combining power of the plasma (alkalosis). Haden and Orr believe that the decrease in chlorides is due to a fixation of the chlorine ion in the tissues by the toxin which is formed within the intestinal tract. As suggested by Cooper, however, these observers did not take into consideration the large volume of fluid present in the dilated portions of the upper intestinal tract of animals. Raine and Perry have shown that in rabbits a typical hypochloræmia occurs in low intestinal obstruction as frequently as in high intestinal obstruction if a long enough time is allowed to elapse. Copher and Brooks, on the other hand, were unable to find a decrease in the blood chlorides in animals with a high closed intestinal loop. They believe that the hypochloræmia is not due to fixation of the chloride radical but is due to loss of the chlorides in the vomitus as occurs in cases of pyloric obstruction. Because they obtained the characteristic changes following intestinal obstruction in rabbits and monkeys which do not vomit, Haden and Orr believe that the hypochloræmia cannot be explained in this manner. In those cases, both clinical and experimental, in which in addition to mechanical obstruction of the gut there is an interference with the blood supply, additional symptoms and signs occur.

Numerous theories have been advanced to explain the symptoms in acute intestinal obstruction. The following are the principal theories.

1. *The intoxication theory.* The intoxication theory presupposes that a toxin is formed within the bowel which is absorbed into the blood stream, producing characteristic symptoms and signs.

a. Toxins resulting from putrefaction of stagnating food within the intestinal tract (Amussat, Bokai, Albeck, Lepine and Mollier, Roger and Garnier, Magnus-Alsleben). Magnus-Alsleben found that following intestinal obstruction ingestion of any food except milk invariably produced a toxin. Cannon, Dragstedt, and Dragstedt found that, in intestinal obstruction, diet had no effect on the bacterial flora. There is relatively little evidence to support the theory that intoxication is the result of absorption of putrefactive substances. Putrefaction is relatively rare in the

upper intestinal tract where the most marked symptoms occur following intestinal obstruction (Ochsner).

b. Toxins arising from bacterial invasion of the obstructed gut (Murphy and his co-workers, Clairmont and Ranzi, Cannon, Dragstedt and Dragstedt, Kirschstein, Williams). Murphy and Brooks found that a normal gall bladder could be obstructed without the production of any signs of intoxication. If, however, following obstruction and interference with the nutrition of the gall bladder, bacteria obtained from the intestine were introduced into the gall bladder, symptoms identical with those seen in cases of intestinal obstruction were observed. Fluid from such a gall bladder, when injected into another animal, was also toxic. Dragstedt and his co-workers are of the opinion that it is never possible to sterilize an intestinal loop completely. Relatively recently Williams, an English surgeon, advanced the theory that the intoxication seen in intestinal obstruction and ileus associated with peritonitis was similar to and probably dependent upon a bacillus welchii infection. He found that this organism grew best in a neutral or slightly acid medium, and for this reason grows more luxuriantly in the upper than in the lower portions of the intestinal tract. He reports very good clinical results from the use of immune serum in the treatment of such cases. Stabins and Kennedy as well as McIver, White, and Lawson found that following the production of an intestinal obstruction the number of bacillus welchii in the gut increased remarkably. Bower and Clark have obtained very good results clinically from the use of perfringens antitoxin in intestinal obstruction. Morton and Scabins have obtained some benefit following administration of the bacillus welchii antitoxin in experimentally produced intestinal obstruction. On the other hand, Oughterson and Powers obtained no favorable results either from the administration of the antitoxin or from the active immunization of animals against the Welch bacillus. Owings and McIntosh also obtained negative results, employing the bacillus perfringens antitoxin.

c. Intoxication resulting from the absorption of normal secretions in an abnormal way or secretions which have not been toxified (Charrin, Draper and his co-workers, Cybulski and Tarchanoff, McKenna, Sweet, Peet, and Hendrix). Draper believes that most of the intoxications are the result of absorption of the duodenal as well as the pancreatic secretions before they can be detoxified by the ileal cells. As proof of the detoxifying power of the cells of the lower jejunum and ileum he fed animals, with intestinal obstruction, cells derived from the lower jejunum and ileum and found that they lived twice as long as the control animals. Sweet, Peet, and Hendrix found that a closed loop of the ileum did not produce symptoms for periods of time. If, however, pancreatic juice or a piece of pancreas were introduced into the loop, very definite signs of intoxication occurred immediately. Recently Seulberger, Brandes, and Beykirch showed that the presence of both the biliary and pancreatic secretions in the intestinal tract in the presence of intestinal obstruction produced symptoms and signs of intoxication much earlier than either the pancreatic or biliary secretions alone. Much more extensive hepatic lesions were observed in the former group of experiments than in the latter.

d. Intoxications produced by the absorption of perverted intestinal secretions (Whipple and Stone and their co-workers, Ellis, Bunting, and Jones). Whipple and Stone and their co-workers believe that in obstruction the normal function of the cells of the duodenum is lost, and that they secrete a substance which is toxic. These observers believe that by destroying the mucosa, as they did by injecting sodium fluoride solution into a closed loop of the intestine, the formation of the toxin may be prevented. Sweet, however, believes that this group of experiments is open to criticism because the destruction of the mucosa does not necessarily interfere with the development of toxins but rather interferes with the absorption of them. Ellis found that if the toxin from a closed loop of intestine were injected intravenously into another animal, a toxin appeared simultaneously in the lumen of the intestinal tract of the second animal. This was also found in animals in which a bilateral adrenalectomy had been

performed. Cutting, working in the surgical laboratory at Tulane University, found that adrenalectomized rabbits were unable to withstand the injection of toxins prepared from the gut of obstructed animals as well as control animals. He believes that degenerative changes which are found consistently in the cortex of the adrenal in ileus are responsible, in part at least, for the susceptibility of the animal to the toxin formed within the gut.

e. Bacteriæmia. The theory that the symptoms in intestinal obstruction are due to the absorption of bacteria is at the present time not generally accepted in spite of the fact that Borscéky and Generisch found that in experimentally produced intestinal obstruction bacillus coli could be found in the peritoneum or blood or both.

2. *Non toxic causes.* a. Dehydration. It is considered by some that the symptoms in intestinal obstruction may be due to other factors besides intoxication. The one theory that has been most frequently accepted is that of dehydration (Hartwell and Hoguet). Dehydration is always present in those cases in which vomiting is a prominent symptom. Haebler has shown, however, that the symptoms in high intestinal obstruction are not due to dehydration.

b. Blood changes. Because of characteristic blood changes, i.e., decrease in plasma chlorides, increase in the carbon dioxide combining power of the plasma, and an increased urea nitrogen, it is considered by some observers that certain if not all of the symptoms and signs in ileus are dependent upon these changes (Haden and Orr, Gatch, Trussler, and Ayers, Burgess, Walsh and Ivy).

At the present time it is quite generally accepted that, in those cases of intestinal obstruction in which there is some interference with the blood supply to the gut, in addition to dehydration and rather typical blood findings, there is an associated intoxication. Assuming that the symptoms are due to intoxication it is desirable to ascertain the nature of the toxin. Unfortunately, however, it has been impossible, in spite of frequently repeated attempts, to determine the chemical nature of such toxins. The toxin is supposed by most observers to be the result of an incomplete cleavage of the protein molecule. Murphy and Brooks as well as Whipple, Cook, and Stearns, and Wilkie consider it a proteose. Gley and LeBas and Ellis do not believe that it is a proteose because the former authors were unable to obtain an increase in lymph flow following the introduction of the toxin, and the latter found that the toxin was unaffected by the addition of erepsin and trypsin which normally digest the proteoses and heteroproteoses. Gatch and his co-workers and Dale believe that the substance is a histamine-like product. Nesbitt believes that the toxin is neurin. Schoenbauer believes that the toxic substance is trypsin. Dragstedt, Dragstedt and their co-workers felt that it is similar to the toxic amines. An outstanding criticism of the experimental work performed in the isolation of the toxin is that with but two exceptions the toxin has been obtained from the lumen of the intestinal tract and has not been demonstrated within the blood stream. However, Sugito and Scholefield found that if the blood obtained from the portal and mesenteric veins of animals dying from intestinal obstruction were injected into mice, death resulted.

SYMPTOMS AND SIGNS OF ACUTE INTESTINAL OBSTRUCTION

In considering acute intestinal obstruction, it is essential to distinguish between two varieties of ileus, namely, the mechanical and the adynamic, the first being much more frequently found than the latter. However, every surgeon has seen an association of the two types. Doctors Gage, Cutting, and I have been able to demonstrate this association experimentally. In all cases of mechanical obstruction which have existed a relatively long time there is superimposed upon the mechanical obstruction a certain degree of adynamic ileus. One of the earliest symptoms in a mechanical obstruction of the intestine is pain which is characteristically colicky and intermittent. In acute intestinal obstruction obstipation is often lacking and too much dependence should not be placed upon this symptom. In fact not infrequently following the onset of the patient's symptoms one or two evacuations of the bowel occur,

probably due to hyperperistalsis in that portion of the gut below the obstruction. Vomiting may be an early symptom, especially in obstruction high in the intestinal tract. Whether the vomiting is due to a reversed peristalsis, carrying the intestinal contents into the stomach or whether it is due to an increase in gastric secretion associated with complete loss of gastric motility as recently presented by Mueller is not known. Mueller believes that in ileus, especially the adynamic variety, there is a diminution in peristaltic activity, an increase in the gastric and intestinal secretions, and a relaxation of the pyloric and cardiac sphincters, which allows the fluid within the intestinal tract to regurgitate into the stomach. Hyperæmia of the gut wall is supposedly responsible for these changes.

Examination of the abdomen often reveals nothing of significance especially in high intestinal obstruction. In acute intestinal obstruction located relatively low in the intestinal tract there may be considerable distention proximal to the obstruction. The absence of distention, however, should never cause one to hesitate in making a diagnosis of acute intestinal obstruction. Auscultation of the abdomen should never be neglected in a case of suspected intestinal obstruction. In cases of a mechanical obstruction early there is a marked increase in peristaltic activity which can easily be elicited by auscultation. In the adynamic variety, however, in contrast to the normal peristaltic sound the abdomen is "ominously silent" (Deaver).

Although usually not of diagnostic importance the determination of the plasma or whole blood chlorides, the non-protein nitrogen of the blood, and the carbon dioxide combining power of the blood are extremely important from the standpoint of prognosis. Recently Scholefield has suggested that a determination of the blood urea may serve as a diagnostic aid. He states that observations made at the Presbyterian Hospital in New York have shown that values up to ten times normal are sometimes found. The usual figures in patients with intestinal obstruction are from four to five times the normal figure. In addition to the increase in the non-protein nitrogen of the blood, which is due almost entirely to the increase in blood urea, there is characteristically in high intestinal obstruction a decrease in the carbon dioxide combining power of the plasma, i.e., an alkalosis.

DIAGNOSIS OF ACUTE INTESTINAL OBSTRUCTION

The diagnosis is made largely on the basis of the symptoms corroborated by the history. In acute high intestinal obstruction a diagnosis should be made before the condition has progressed to such a degree that physical examination is of value. The diagnosis of mechanical ileus is usually not difficult if the condition is only considered by the surgeon. The history of intermittent, colicky abdominal pain is indicative of obstruction to a hollow viscus. If there is a history of previous laparotomy, the possibility of an "adhesions ileus" should be considered. The presence of external herniæ, the contents of which cannot be reduced, would facilitate a diagnosis of mechanical ileus. Postoperative ileus may be of the adynamic or of the mechanical variety. The diagnosis of an ileus developing postoperatively is relatively difficult. As repeatedly emphasized by Dr. Ochsner, a patient in whom an intestinal obstruction is suspected should receive nothing by mouth, especially no cathartics.

A valuable diagnostic procedure not sufficiently appreciated is the roentgenography of the abdomen without the administration of contrast substances. First advocated by Schwarz in 1911, this procedure has become popular in the European continental clinics, but, unfortunately, is used relatively infrequently in the United States. Case has, however, been instrumental in introducing this procedure into this country. As is duly appreciated by all surgeons, the administration of a contrast substance to a patient in whom an intestinal obstruction is suspected is not without danger. Not infrequently an incomplete obstruction may be transformed into a complete obstruction as a result of the administration of an opaque meal. In suspected obstructions of the large bowel, it is, however, permissible and at times advisable to examine the large bowel by means of a contrast enema. Roentgenography of the abdomen without

the administration of a contrast substance is, on the other hand, entirely without danger. Because of the increased secretion and diminished absorption from the gut proximal to a mechanical obstruction or in loops of gut in adynamic ileus, there is an accumulation of fluid and gas within the gut. As emphasized by Schwarz, Assmann, Case, and others the presence of abnormally large collections of gas in the small bowel are indicative of some obstruction. More significant, however, than the presence of gas in the intestine is the presence of numerous fluid levels in various parts of the abdomen, when the patient is examined in the erect position. The fluid contents of the intestine assume a dependent position in the loop of gut and are "capped" by gas in the same loop. As this occurs in several loops, such multiple fluid levels can be demonstrated in various parts of the abdomen. Such a roentgenogram is pathognomonic of ileus.

Whenever possible it is essential, before operation, to differentiate between ileus of the obstructive variety and ileus of the adynamic variety, because operative relief of the former is the only therapy which is of any avail, whereas surgical intervention in the latter type is of little value. As early as 1922, Wagner suggested that lumbar anæsthesia might be used as a diagnostic procedure in ileus for differentiating the adynamic from the obstructive type, because of the beneficial results which he had obtained following the use of lumbar anæsthesia in the treatment of ileus. Recently Willard Bartlett, Jr., and W. J. Mayo have again suggested such a procedure as a diagnostic aid. The employment of splanchnic block either as a lumbar analgesia or as a spinal analgesia is not reliable in differential diagnosis as is shown by Duval's series of cases. Duval found that an evacuation of the intestines was produced in 16 per cent of the cases of mechanical ileus in which lumbar analgesia had been performed.

PROGNOSIS

The prognosis in intestinal obstruction depends upon several factors. Of most importance is the time of operation; the earlier the operation, the better the prognosis. As aptly stated by Van Beuren, "the longer a patient with intestinal obstruction lives before operation, the sooner he dies afterward." Miller states that the mortality rises approximately 1 per cent for each hour of procrastination. Van Beuren, in experimentally produced intestinal obstruction, found that within 48 hours 25 per cent of the animals showed intestinal damage, whereas after 48 hours 60 per cent showed damage. He also found that 75 per cent of the animals with obstructions of 48 hours' duration recovered following the relief of obstruction, whereas 75 per cent of the animals in which an obstruction had been present for 72 hours died after such operation. In a series of 343 cases of intestinal obstruction reported by Miller, the mortality rate when the patient was subjected to operation within 12 hours after the onset of symptoms was 29.4 per cent; within 24 hours, 52.9 per cent; within 36 hours, 50 per cent; within 48 hours, 59.6 per cent; within 72 hours, 63.4 per cent; within 96 hours, 72.8 per cent, and over 96 hours, 84 per cent. In a series of 83 cases of intestinal obstruction reported by Brill the mortality rate when operation was performed within 72 hours of onset of symptoms was nil; when performed between 12 and 24 hours, 12.5 per cent; between 24 and 48 hours, 61.1 per cent.

The increase in mortality as the case progresses is undoubtedly due to an interference with the blood supply of the gut superimposed upon the mechanical obstruction. This is dependent upon the increase in the intra-intestinal pressure above the point of obstruction. Owings, McIntosh, Stone, and Weinberg and Morton have shown that interference with the blood supply occurs more frequently in the upper part of the intestinal tract than in the lower part because of the more rapid increase in intra-intestinal pressure. In considering the prognosis in intestinal obstruction, it is necessary to distinguish between simple mechanical obstruction, in which there is no interference with the blood supply of the gut and one in which this interference has become established. It is quite generally accepted that in the former type of case signs and symptoms of intoxication never occur. As already mentioned, changes in the

blood may occur; Brooks, Schumacher, and Wattenberg have shown experimentally that a closed intestinal loop could be tolerated by an animal for 21 days, provided there was no strangulation of the blood supply or marked distention of the gut, even though the loop supposedly contained eight hundred times the lethal dose of toxin.

It is also necessary to distinguish in ileus between cases of the mechanical variety and cases of the adynamic variety, always remembering that the two may be combined. The prognosis in the latter type is much worse than in the former. The most frequent cause of mechanical obstruction is hernia, followed in frequency by adhesions. In Miller's series of 343 cases, hernia was the cause of obstruction in 28 per cent; adhesions in 19.8 per cent; intussusception in 12.2 per cent; volvulus in 9.9 per cent; bands, 8.7; carcinoma, 4.9; thrombosis, 2.

The causes of the adynamic type of ileus are varied. In all probability this type of ileus is the result of an overstimulation of the inhibitory nerves (splanchnics) to the intestines. Peritonitis, lesions within the central or sympathetic nervous system, certain types of abdominal trauma and nerve lesions, certain types of toxæmias are frequent causes of the adynamic type of ileus. As early as 1907 Cannon and Murphy showed that adynamic ileus experimentally produced by crushing the testicles could be prevented by cutting the splanchnic nerves. Markowitch and Campbell and Domenech have shown that spinal analgesia is effective in relieving adynamic ileus. In our laboratory, Gage, Cutting, and I have been able to relieve, experimentally by splanchnic block, physiological, chemical, and adynamic ileus superimposed upon mechanical ileus.

Peritonitis either as a cause of the ileus or as a result of extension of infection from the intestine is of importance as regards prognosis because the prognosis is much worse in the presence of such a complication. I wish here to pay tribute again to Dr. Ochsner who did so much toward placing the prevention and treatment of peritonitis on a sound and rational basis. He emphasized the principle that all food and especially cathartics should be withheld in cases of suspected intestinal obstruction. Schoenbauer has shown that the peritoneal exudate in intestinal obstruction is toxic when given intravenously.

TREATMENT

As stressed in the discussion of prognosis, early operative intervention is of the greatest importance in intestinal obstruction. If a mechanical obstruction can be relieved before distention has progressed to such a degree that interference with the blood supply to the gut has occurred, the mortality should be practically nil. In those patients in whom dehydration is a marked factor, fluid should be administered either subcutaneously or intravenously. Because of the hypochloræmia, chlorides in the form of sodium chloride should be administered. Orr and Haden recommend the intravenous administration of 500 cubic centimeters of a 5 per cent sodium chloride solution preoperatively. Eliason prefers 5 per cent glucose in normal salt solution, whereas McVicar and Weir employ 10 per cent glucose in 1 per cent sodium chloride solution. The latter authors believe the hypertonic glucose solution is of distinct value in promoting diuresis in individuals in whom there is more or less nitrogen retention.

As rigidly practiced by Dr. Ochsner in every case of intestinal obstruction gastric lavage should be performed, especially immediately before operation. "As harmful as is the giving of food and cathartics in these cases, so equally beneficial is the opposite form of treatment by means of repeated gastric lavage, which often removes a considerable amount of poisonous material from the alimentary canal and permits the intestines and the stomach to contract. It also tends to prevent the occurrence of aspiration pneumonia caused by inspiration of fetid intestinal contents regurgitated during the operation" (10). It is also well to leave the tube in place in order to prevent vomiting and possible aspiration while the patient is on the operating table. Because of the danger of vomiting and possible aspiration of the vomitus and because of the possibility of respiratory embarrassment due to elevation of the diaphragm by gas distended intestines,

an inhalation anæsthetic should not be employed. Either a splanchnic analgesia, according to the technique of Kappis, or a spinal analgesia is to be preferred.

The operative procedure varies with the lesion encountered. It is imperative that the obstruction be relieved in some manner. Frequently no attempt should be made to extirpate the obstructing lesion because resection may be more than the patient can survive. There is probably no condition which requires more gentleness than acute intestinal obstruction. Bunnell states: "Every manipulation is a shove nearer the grave." In such a case the operative procedure of simple drainage of the intestine above the obstruction is the method of choice. It is far better to have a living patient who requires a secondary operation than a dead one in whom the operation was completed. Heidenhain advocated an enterostomy in acute ileus as early as 1897. Lennander because of the severe toxæmia present in high intestinal obstruction, believed that the toxic products were absorbed from the upper jejunum and advocated jejunostomy in intestinal obstruction. Lee and Downs advise a jejunostomy performed as high as possible. Haden and Orr found, experimentally, that animals in which a jejunostomy was performed at the same time a high intestinal obstruction was produced lived a shorter period of time than those animals in which no jejunostomy was performed. Recently these authors have reported the successful use of enterostomy performed in the ileum in cases of peritonitis. Experimentally, they were able to show that simple enterostomy did not prolong the life of an animal, but that enterostomy plus the addition of 1 per cent sodium chloride solution, hypodermically, tripled the life of the animal. They state: "When any doubt exists concerning the value of enterostomy, it should be done." Scholefield reports that from the years 1916 to 1920 in 4 cases of paralytic ileus following appendicitis in the Presbyterian Hospital in New York, an ileostomy was performed with a 75 per cent mortality, and in 8 cases seen in this hospital from 1916 to 1920 a jejunostomy was performed with a mortality of 37.5 per cent. This author believes that the failure of low enterostomies to drain the bowel adequately is due to the length of the intestine which becomes paralyzed, forming a series of obstructed loops above the point of drainage. He believes that a high ileostomy or jejunostomy provides an escape for the secretions of the duodenum or upper ileum. Van Beuren studied the cases of acute ileus operated upon during the past 12 years in the Presbyterian Hospital in New York. The time was divided into three periods of 4 years each. In Van Beuren's series of cases it was shown that the diagnosis of acute ileus was made more frequently than previously as evidenced by the increased number of cases in the later periods. The mortality rate was materially reduced during the last 8 years, especially during the last 4 years. Enterostomy was used more frequently than previously—one-third of the cases in the first period, one-half in the second period, and three-fourths in the third period. There was a greater reduction in the average mortality of cases treated by enterostomy than those which were not so treated, 38 per cent lower in the enterostomy group, 29 per cent lower in the non-enterostomy group. The number of late cases seen in the last 4 years increased over those seen in the previous 4 years. However, there was a decrease in mortality of 13 per cent. Van Beuren states: "Enterostomy done at the right time in the right way is the most effective means we have at present to relieve and prevent intestinal overdistention and anæmia."

Following the relief of obstruction either by enterostomy or relief of the obstructive lesion, the postoperative treatment of the patient is extremely important. Until normal peristalsis is established everything should be withheld by mouth, a procedure which was strictly emphasized by Dr. Ochsner. The patient should receive every 24 hours either subcutaneously, intravenously, or rectally, from 3 to 5 liters of fluid. The fluid is administered as 1 per cent saline or 5 per cent glucose solution intravenously, normal saline hypodermically, and either physiological saline solution, 2 per cent glucose solution, or tap water per rectum. Frequent examinations of the blood should be made to determine the presence

or absence of a hypochloræmia as well as a determination of the carbon dioxide combining power of the plasma. In severe cases of alkalosis Gage has successfully employed acid sodium phosphate intravenously in a 1 per cent solution. Frequent gastric lavage is imperative. As practiced very successfully by Dr. Ochsner, the application of heat to the abdomen by means of an electric light tent is of immense value. Mueller believes that in "paralytic ileus," there is a decrease in movement of the intestinal tract and an associated increase in secretion. Because of the viscero-splanchnic balance he believes that the application of heat to the abdomen by producing a dilatation of the peripheral vessels causes a contraction of the splanchnic vessels. In so doing the secretion is diminished and motility increased. As an agent to stimulate peristalsis the application of heat to the abdomen has in our hands been the most valuable one which we possess.

The treatment of adynamic ileus either as a primary lesion or as a lesion superimposed upon a mechanical ileus which has been relieved is the same as that of the mechanical variety, except possibly operative interference. It is in this type of ileus that splanchnic block is of greatest value, either as a spinal or splanchnic analgesia. Recently, Gage, Cutting, and I compared the effects of both spinal and splanchnic analgesia on normal animals and on those with intestinal obstruction, employing not only novocain but also nicotine, as recommended by Rosenstein and Koehler, as the anæsthetic substance in the splanchnic area and novocain in the dural sac. Contrary to the apparently brilliant and highly satisfactory results obtained both clinically and experimentally by Rosenstein and Koehler by the injection of nicotine solution into the splanchnic area, we found that nicotine employed in this manner is a dangerous drug because of the production of very marked increases in blood pressure. The effect on the gut was also minimal. Comparing the results obtained following the introduction of novocain solution into the splanchnic area and into the dural sac, we found that in the former instances the effect on the gut was more marked than in the latter. In both types of cases there was a decrease in blood pressure, which, however, was greater following spinal analgesia than following splanchnic analgesia. Clinically, splanchnic block has been successful in relieving adynamic ileus in a number of cases. We feel from our experimental work that the induction of splanchnic analgesia is to be preferred to the induction of spinal analgesia.

There has been considerable controversy concerning the efficacy of different drugs in the treatment of adynamic ileus. The drugs which are most frequently employed are some form of pituitary extract, physostigmine or eserine, peristaltin, choline or acetyl choline, and some few others. Blair Bell was the first to employ a pituitary extract in the treatment of ileus. Since his original report in 1911, numerous reports have been made, many of which have been favorable, others which have been unfavorable. It might be said from a review of the literature that the most favorable results are reported by clinicians, the least favorable results are reported by scientists whose observations have been undoubtedly more carefully made and in a more critical manner. In our laboratory Drs. Cutting, Gage, and I have found that, with but few exceptions, pituitary extracts, both pituitrin and pitocin, exert a depressing effect on both the normal and the obstructed gut, as evidenced by cessation of intestinal movement and loss of intestinal tone. Exceptionally an increase in intestinal activity was noted. Extracts of the calabar bean were first used by veterinarians in the treatment of obstruction in animals. Active principles of this bean are used in medicine today in the form of physostigmine or eserine There are a number of clinical reports advising the use of this alkaloid. Owings and McIntosh showed that eserine was much more efficient in increasing the intra-intestinal pressure than was pituitrin, the latter almost invariably exhibiting a relaxing effect on the gut. Martzloff in a series of patients studied on the gynecological service at the Johns Hopkins Hospital who received, after operation, eserine salicylate, grain 1/100, strychnine sulphate, grain 1/40, hypodermically, every 4 hours for 8 doses, found that eserine and strychnine

given in these doses exerted no valuable prophylactic effect on the gut. Our own results indicate, however, that eserine in fairly large doses is occasionally capable not only of increasing the intra-intestinal pressure by increasing the intestinal tone, but also of increasing intestinal movement. Peristaltin in our hands exerted an inconstant effect on both normal and obstructed intestines. Choline has been used rather extensively, especially by German observers in the treatment of ileus. Because it supposedly has a hormone inducing intestinal activity, theoretically it should be an ideal substance for this purpose. However, in our hands in the experimental laboratory this substance is of no value either in increasing the tone or increasing the intestinal movement. Hughson and Scarff found that intravenous administration of a hypertonic sodium chloride solution produced violent peristalsis in animals. This observation was corroborated by Ross and by us. Numerous clinical reports have been made concerning the use of this substance.

CONCLUSIONS

1. In all cases of ileus there are varying degrees of vascular occlusion; in the high obstructions the vascular disturbance may be intramural.

2. The prognosis in ileus depends upon the length of time which has elapsed since the onset, the location of the obstruction, and the previous therapy. Blood chemistry determinations are of value for prognosis and proper treatment.

3. Symptoms and signs of ileus are usually characteristic. Plain roentgenograms of the abdomen with the patient in the upright position without the administration of contrast media are of value in diagnosing ileus.

4. Early operation or relief of obstruction in ileus is imperative.

5. Enterostomy is of value in both the adynamic and obstructive types of ileus, provided enterostomy alone is not employed.

6. Splanchnic block, preferably by means of a splanchnic analgesia (Kappis) is of distinct value in adynamic ileus.

7. Drugs are of little or no value in the treatment of ileus.

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THE EFFECT OF INJECTIONS OF FEMALE SEX HORMONE (ŒSTRIN) ON CONCEPTION[1] AND PREGNANCY IN THE GUINEA PIG[2]

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THE relationship between the length of the œstrous cycles and the gestation periods of various mammals, including man, has long been noted. That is, the gestation period is some multiple of the cycle. For instance, in the guinea pig, the gestation period is about four times the length of the cycle and in the human ten times.

It is also a matter of common knowledge that abortions are especially apt to occur at the end of the first period in the pregnancy, less so at the second, and so on. It has been generally thought and recently proved by Corner and Allen (1, 3, 4) that the corpus luteum hormone has an essential part to play in the nidation of the ovum. Probably it plays an equally important part also in the preservation of the life of the embryo for some time after nidation, though its removal in early pregnancy without death of the young has been reported by L. Loeb, in the guinea pig. On the other hand, Parkes and Bellerby in the mouse and Corner (3) in the rabbit find that removal of the corpora lutea causes premature termination of the pregnancy.

Is there a balance between the corpus luteum hormone and the hormone that produces œstrus? It has been conclusively shown that the corpus luteum has an effect inhibitory to œstrus. In the guinea pig, Papanicolaou demonstrated definite postponement of the onset of œstrus by injections of corpus luteum hormone. This work has been corroborated in the rat by Pereya, and in the guinea pig by Macht et al.

Thus, two clear cut functions of the corpus luteum were demonstrated by the experimental method: first, its importance in the early life of the ovum, and, second, its ability to offset the œstrus producing hormone and prevent heat.

On the other hand, it had been shown that the female sex hormone was the active agent in producing œstrus and that injections of it would throw even castrated animals into heat.

It was also known that the corpus luteum undergoes degenerative changes later in pregnancy. Textbooks of embryology have long stated this for the human, and changes have been demonstrated in the rat by Long and Evans, using the vital staining method.

The writer has shown that injections of serum from pregnant women delay the onset of œstrus in guinea pigs, indicating an excess of corpus luteum in women's blood during gestation.

This conception of antithetic actions of the female sex hormone and the corpus luteum hormone led to the hypothesis that labor may result from the newly gained ascendency of the female sex hormone over that of the degenerating corpus luteum, and pregnancy thus be terminated. Rucker writes of the "relation of the ovarian hormone to the onset of labor" and Glismann of "recurrent abortion (prevention with corpus luteum extract)."

The fact that certain animals go into œstrus, copulate, and ovulate immediately after parturition, strengthened this conception, as it was easy to consider that the accumulating œstrin necessary for the heat period gradually came to exceed the corpus luteum and, having gained the ascendency, rendered the continuation of pregnancy impossible.

About the time this theory was formulated by the writer, confirmatory evidence was forthcoming. Two papers were published, the contents of which were in line with this thought. Margaret Smith reported that she had been able by injecting female sex hormone into pregnant white rats to terminate the pregnancy, if it had not exceeded 5 days. She was also able to prevent conception. The largest dose she administered was 80 rat units of hormone.

Parkes and Bellerby using white mice, reported that they were able to prevent conception and to interrupt pregnancy at any stage, with comparatively small doses (1 to 5

[1] By conception is meant not fertilization, but the act of becoming pregnant (nidation of the ovum).

[2] Contribution No. 6, Series B, from the Department of Anatomy, Medical Department, University of Georgia. Read before the American Association of Anatomists, Charlottesville, Virginia, April 19, 1930. This work has been aided by a grant from the Committee for Research in Sex Problems, National Research Council.

TABLE I

Animal	Cop. date	Time	Peptone c.cm.	Injections	Total c.cm.	Result
1149	6–5–29	9:10 a.m.	0.5	6	3	Conceived
1175	6–5–29	4:50 p.m.	0.5	6	3	Conceived
1057	6–5–29	5:10 p.m.	0.5	6	3	Œstrus 6/23

TABLE II

Animal	Cop. date	Pregnant days	Peptone c.cm.	Injections	Total c.cm.	Pregnancy
1152	2–22–29	28	2½	9	22½	Unaffected
1154*	2–28–29	40	5	9	45	Unaffected
1040	3–22–29	42	1	11	11	Unaffected
1127	3–28–29	35	1	12	12	Unaffected
1139*	4–3 –29	28	1	12	12	Unaffected

*These two animals were subsequently used in another experiment.

mouse units), though the dosage needed in the latter part of pregnancy was about twice as large as in the first half.

With the exception of a short report by Loeb, apparently no further investigation of this problem by this method has been reported. The experiments reported by Loeb are so indefinite and the results so inadequate, that little comment is needed. No dosage is reported and no interruptions of pregnancy. He also states that the vagina did not open during injections and this would indicate that his dosage was too small.

Other reports that have a bearing on this question have appeared since the work of Smith and of Parkes and Bellerby and will be referred to later.

MATERIAL AND METHOD

The animals used in this investigation have been fully mature female guinea pigs, fed on a diet adequate for reproductive purposes, and housed by pairs in well kept cages. Injections were made in several groups, as follows: (a) administration of œstrin just after copulation; (b) administration of peptone solution to controls just after copulation; (c) œstrin to pregnant animals at various stages (from 2 to 8 weeks); (d) peptone solution to pregnant controls; and (e) œstrin to males and non-pregnant females for a study of its toxicity.

The hormone used was furnished by two biological supply houses and had been assayed

TABLE III

Animal	Cop. date	Time	Rat units	Injections	Units total	Prevent conception	Return to heat
1054	4–26–29	10:55 a.m.	20	6	120	Yes	5–13 9
1145	5–13–29	12:55 p.m.	20	6	120	Yes	5–21 9
1058	5–20–29	9:10 a.m.	20	6	120	Yes	5–30 9
1104	6–12–29	10:25 a.m.	20	6	120	Yes	6–21 9
1131	6–14–29	10:15 a.m.	20	6	120	Yes	6–23 9
1022	6–14–29	10:32 a.m.	20	6	120	Yes	6–25 11
1270	12–14–29	4:00 p.m.	10	6	60	Yes	12–20 6
1266	12–23–29	11:00 a.m.	10	6	60	Yes	1– 5 13
1028	2–14–30	....	5	3	15	Yes	2–28 14
1118	3– 2–30	....	5	3	15	Yes	3–17 15
1199	2–20–30	....	5	3	15	Yes	3– 7 15
1195	3–20–30	....	5	2	10	Yes	4– 3 14
1273	3–20–30	....	5	2	10	Yes	4– 3 14
1060	3–24–30	....	5	2	10	Yes	4– 8 15
1193	3–24–30	....	5	2	10	Yes	4– 8 15
1231	3–28–30	....	5	2	10	Yes	4–10 13

by the Allen and Doisy method.[1] It was found fully potent. On account of the large doses used in late pregnancy, we were fortunate in obtaining also[2] a large supply of hormone in oil that assayed 500 rat units to the cubic centimeter. This product was diluted with a small quantity of glycerine and injected subcutaneously in the back region. Since a fifth of a cubic centimeter contained 100 rat units (the largest single dose administered), the volume injected was usually small.

Injections were as a rule given over a period of 6 days in equal doses, though some were given for only 3 days, or less, and others as long as 23 days. In the later stages of pregnancy, very large doses of œstrin were used because Parkes and Bellerby found that in the mouse about twice as much hormone was necessary to interrupt pregnancy then as in the first stages.

A number of pregnant animals used for controls received injections of one per cent peptone solution over periods varying from 9 to 12 days, in amounts varying from 1 to 5 cubic centimeters per day. Controls used in

[1] For further information concerning the Squibb product see J. Am. M. Ass., 1929, xcii, 1678. This account states it is free of protein and cholesterol.

[2] From Dr. J. F. Anderson of E. R. Squibb & Sons.

TABLE IV

[illegible]-mal	Pregnant days	Rat units	Injections	Units total	Aborted	Delivered	Died
[illegible]3	17	25	6	150	Yes	No	No
[illegible]4	17	25	6	150	Yes	No	No
[illegible]1	12	25	6	150	Yes	No	No
[illegible]4	12	12.5	6	75	Yes	No	No
[illegible]2	15	12.5	6	75	Yes	No	No
[illegible]7	17	12.5	6	75	No	Yes	No
[illegible]6	14	12.5	6	75	Yes	No	No
[illegible]8	13	12.5	6	75	Yes	No	No

TABLE V

Animal	Pregnant days	Rat units	Injections	Units total	Aborted	Delivered	Died
1120	32	50	6	300	Yes	No	Yes
1265	28	50	6	300	No	No	Yes
1250	28	50	6	300	No	No	Yes
1131	28	50	6	300	Yes	No	No
1012	31	50	6	300	No	No	Yes
1263	29	50	6	300	Yes	No	No
1264	29	50	6	300	Yes	No	No
1255	31	50	6	300	Yes	No	Yes
1125	27	50	6	300	No	No	Yes
1218	30	50	6	300	Yes	No	No
1029	30	50	14	700	No	No	Yes
1041	28	50	14	700	Yes	No	Yes

the test for prevention of conception received six daily injections of 0.5 cubic centimeter each.

RESULTS

Prevention of conception controls. This group of animals was the smallest used in any test. Three were injected with a half cubic centimeter of one per cent peptone solution on 6 successive days. Two of the animals conceived and one did not (Table I).

Pregnant controls. Five animals comprised this group. They were given doses of one per cent peptone solution varying from 1 to 5 cubic centimeters over periods ranging from 9 to 12 days. The total quantity injected varied from 11 to 45 cubic centimeters. None of these animals had the course of pregnancy affected by the treatment (Table II).

Prevention of conception. In this series 16 animals were used and the dosage ranged downward from a total of 120 rat units to as low as 10 units, given in equal amounts over a 6 day period. An effort was made to ascertain the smallest dose that would prevent conception. Of 6 animals that received 120 units, none conceived. Of 2 that received a total of 60 units, neither conceived. Of 3 animals that received a total of 15 units, none conceived, and of 5 that received a total of 10 units, none conceived. It is noteworthy that the animals that received the larger doses of œstrin had short intervals between heat periods (with one exception), only 10 to 12 days, whereas the others had normal cycles (Table III).

Copulation was checked in each case by the finding of fresh sperm in vaginal smears.

Animals about two weeks pregnant. In this group of 8 animals, the duration of pregnancy ranged from 12 to 17 days. The total dosage of hormone varied in each case from 75 to 150 rat units, given in the usual manner (6 equal injections). All 3 of the animals that received 150 rat units aborted. Of the 5 remaining animals, receiving 75 units each, 4 aborted, and 1 was delivered at term. None of these animals died (Table IV).

Pregnancy was corroborated by the predominance of blood in the vaginal smears at the time of abortion. Moreover, in a group of this size, not less than three-fourths would have conceived after copulation.

Animals about four weeks pregnant. These animals were divided into two groups, one receiving large doses of hormone and one receiving decreasing doses, as an effort was being made to ascertain the smallest average effective dose.

In the first group 12 animals were used. The duration of pregnancy varied from 27 to 32 days. Ten animals received a total dosage of 300 rat units. Of these, 6 aborted and 4 died with retained fetuses. In this whole group 7 animals aborted and of these, 3 died. Eight of the 12 died, 5 with retained, macerated fetuses (Table V).

In the second group of this series the smaller dosage did not take such a heavy maternal toll. Seven animals were used. Three received 150 units, two 120 units, and two 90

TABLE VI

Animal	Pregnant days	Rat units	Injections	Units total	Aborted	Delivered	Died
1261	28	25	6	150	Yes	No	No
1252	28	25	6	150	Yes	No	No
1266	28	25	6	150	Yes	No	No
1057	26	15	6	90	Yes	No	No
1231	26	20	6	120	Yes	No	No
1156	27	20	6	120	Yes	No	No
1158	27	15	6	90	No	Yes	No

TABLE VII

Animal	Pregnant days	Rat units	Injections	Units total	Aborted	Delivered	Died
1153	44	100	9	900	No	No	Yes
1154	50	50	23	1150	No	No	Yes
1118	49	50	13	650	Yes	No	No
1051	42	50	15	750	No	No	Yes
1127	45	100	6	600	No	No	Yes
1110	42	100	6	600	No	No	Yes
1257	42	100	6	600	Yes	No	No
1272	42	100	6	600	No	No	Yes
1249	42	100	6	600	No	No	Yes
1247	43	100	6	600	No	No	Yes
1260	44	100	6	600	No	No	Yes
1262	43	100	6	600	No	No	Yes

units each. Of these, 6 aborted and 1 went on to normal delivery. This last animal was one of the two that received only 90 rat units (Table VI).

Animals six to eight weeks pregnant. This series of animals was likewise divided into two groups, one receiving quite large doses and the other smaller doses of the hormone.

In the first group there were 12 animals, pregnant from 42 to 56 days. These animals received a total dosage each of from 600 to 1,150 rat units. Only 2 miscarried. The 10 remaining died with retained, macerated fetuses (Table VII).

In the second group 5 animals pregnant from 42 to 46 days received from 300 to 480 rat units and all of these died with retained, macerated fetuses (Table VIII).

Toxicity of hormone in males and non-pregnant females. Since quite a large per-

TABLE VIII

Animal	Pregnant days	Rat units	Injections	Units total	Aborted	Delivered	Died
1003	46	80	6	480	No	No	Yes
1010	44	80	6	480	No	No	Yes
1032	44	60	6	360	No	No	Yes
1246	44	60	6	360	No	No	Yes
1059	42	50	6	300	No	No	Yes

TABLE IX

Animal	Rat units	Injections	Units total	Date injected	Date death
				1929	
1275	100	3	300	12– 7 to 9	12–1
1276	100	6	600	12–12 to 17	Live
1282	100	3	300	12– 9 to 11	12–1
1283	100	3	300	12– 9 to 11	12–1
1040	100	1	100	12–15	12–1
1118	100	6	600	12–15 to 20	Live
1207	100	6	600	12–15 to 20	12–2
1245	100	6	600	12–15 to 20	12–2
1285	100	2	200	12– 9 to 10	12–1
1286	100	2	200	12– 9 to 10	12–1
1047	100	6	600	12–15 to 18	12–1

TABLE X

Animal	Rat units	Injections	Total units	Date injected	Result
				1930	
1046	100	6	600	1–20 to 25	Unaffected
1237	100	6	600	1–20 to 25	Unaffected
1238	100	6	600	1–20 to 25	Unaffected
1001	100	6	600	1–20 to 25	Unaffected
1007	100	6	600	1–20 to 25	Unaffected
1104	100	6	600	1–20 to 25	Unaffected

centage of the animals in advanced pregnancy died following injections of the hormone, an effort was made to ascertain if the hormone itself was toxic in large doses. The results of this experiment are somewhat conflicting, but the fact stands out, nevertheless, that these animals can in many cases receive as much as 600 rat units of the female sex hormone with no ill effects.

In all, 17 animals were injected and these were treated in two groups of 11 and 6. (On account of the lethal effects in the first series, a second was undertaken.)

Fig. 1. Normal non-pregnant guinea pig uterus.

Fig. 2. Non-pregnant guinea pig uterus after six 100 rat unit injections. Some enlargement and increased vascularity, but no destruction as seen in Figure 3, with half the dose.

Of the first 11 animals, 8 were females and 3 were males. The dosage varied from 100 to 600 rat units. One animal died after one injection of 100 units. Two died after two injections of 100 units each. In all, 9 of this group died. The 2 animals that survived received a total of 600 units each. This series of animals consisted of the smallest that were used, many being only half the size of the test animals reported on above (Table IX).

As the results of the foregoing were rather contradictory and as many of the animals used were quite small, another test, using fully grown animals, was decided upon. There were 3 males and 3 females in the group. Each animal received six 100 unit doses in 6 days. None of these animals died or became ill (Table X).

Gross and microscopic study of uterus, placenta, and ovaries. The most marked change in the reproductive organs after injections of female sex hormone was always a vascular one. The increased vascularity was usually easy to observe in the gross and was always prominent in microscopic preparations. There was, however, a wide variation in response among different animals. In some non-pregnant animals doses amounting to 600 rat units would produce no marked change in the uterus or ovaries. In others the same dose or even a smaller amount would result in almost complete obliteration of the uterine glands and cause the greatest hyperæmia. (Possibly the stage of the cycle when the injections were made had some effect. Figs. 1, 2, and 3.)

In pregnant animals the uterus was already hyperæmic and comparisons were difficult. Therefore sections were made through uterus and placenta at their point of union in normal (uninjected) and injected animals. In this way a marked difference was found between the two. In the normal the chorionic villi had the usual appearance, whereas in the test animals the villi were pressed upon by large lakes of blood and were damaged in some cases almost to the point of destruction (Figs. 5, 6, 7, and 8).

Fig. 3. Non-pregnant guinea pig uterus after six 50 rat unit injections. Marked vascularity and destruction of uterine glands.

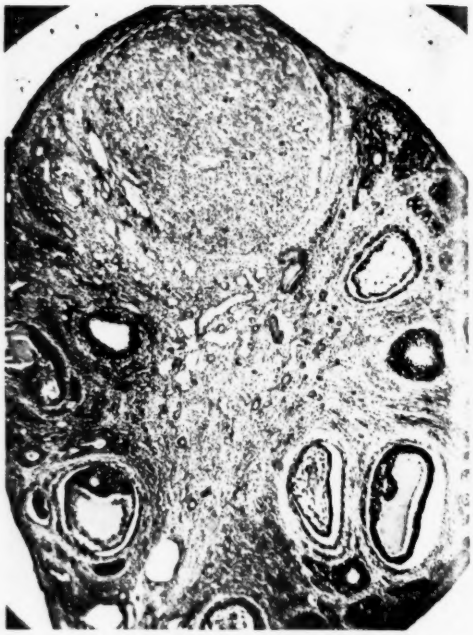

Fig. 4. Guinea pig ovary from pregnant animal after six 100 rat unit injections of œstrin, showing corpus luteum apparently unaffected; also many atretic follicles.

The ovaries sometimes presented quite a number of large follicles and at times only one large cyst; at others they appeared almost normal. In microscopic preparations there was a greater vascularity present and probably on the whole a larger number of follicles, but the variations in the ovaries were not so marked as in the uterus and placenta.

The corpora lutea of pregnancy persisted apparently unchanged, even after numerous injections of large doses of the female sex hormone (Fig. 4).

There was no evidence of ovulation and formation of fresh corpora lutea.

It was the rule for the vagina of the pregnant animals to open during the course of the injections, but the vaginal smears were not usually typical of œstrus. The females were isolated and no attempts were made to breed them.

Always at autopsy, the junction of the uterus and placenta, when the latter was pulled away, had a necrotic appearance. This could have been due to the fact that the fetuses had usually been dead for several days before the death of the mother.

SUMMARY OF RESULTS OF EXPERIMENTS AND CLINICAL APPLICATION

It is interesting to observe the ease with which conception can be prevented by injections of female sex hormone just after copulation. Presumably, at this time, the corpus luteum has not developed far enough to furnish a quantity of hormone sufficient to counteract the injected œstrin. The necessity of the corpus luteum hormone for nidation of the ovum has been nicely demonstrated in the rabbit by the recent experiments of Corner and Allen (1, 3, 4), and had long been so considered (Fraenkel, Ancel and Bouin, and others.)

It is also quite striking with what ease early pregnancy can be interrupted by this method and how the dosage must be increased for

Fig. 5. Chorionic villi as seen in normal pregnant control guinea pig.

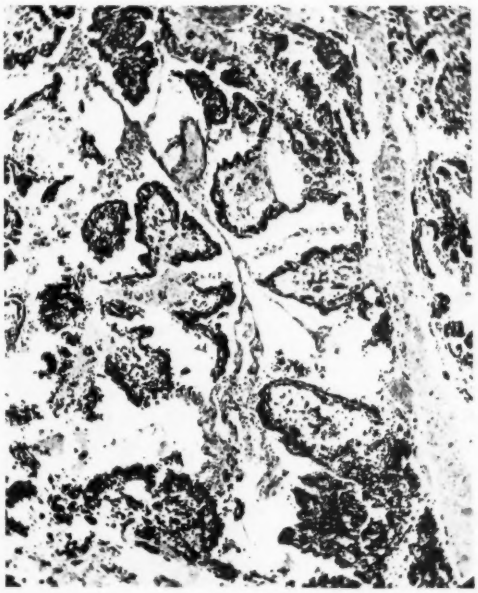

Fig. 6. Chorionic villi after six 100 rat unit injections of œstrin. Note shrinkage and fragmentation.

later stages. This result is in full accord with the findings of Parkes and Bellerby.

The abortions cannot be considered the result of handling or of the treatment with a foreign substance. The control animals received from a 50 to a 100 per cent more injections of peptone solution and volumes far greater than were used in the test animals (from 11 to 45 cubic centimeters) and yet none had their pregnancy interrupted.

A difficult problem is faced when we ask what was the cause of death of the fetuses and the mothers in the latter half of pregnancy. The microscopic study of the chorionic villi suggests that changes in the placenta cause the death of the young. The atrophy of the villi and the great blood sinuses that form around them would seem to bear some relation to this result.

The question arises: why do not the mothers miscarry after the young have died *in utero?* Their macerated condition at autopsy shows that they die days before the mother.

It is a well known fact that the pubic symphysis of the guinea pig dilates an inch or

Fig. 7. Same as Figure 6, showing large area filled with blood.

Fig. 8. Chorionic villi after six 100 rat unit injections of œstrin, showing extreme degree of destruction, with enormous blood invasion.

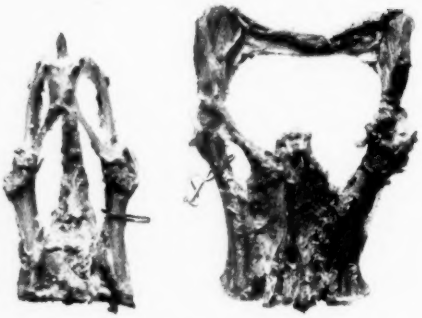

Fig. 9. Guinea pig pelvis, virgin, showing symphysis united.

Fig. 10. Guinea pig pelvis, multipara, showing wide separation of symphysis immediately after delivery.

more at the time of parturition (or just before it), and necessarily so, because the normal pelvic diameters are so much smaller than those of the fetal head at or near term. It should be borne in mind that the gestation period in this animal is unusually long for one of its size (9 weeks), and that the young are born in a well developed state and run around and eat the day they are born (Figs. 9 and 10).

This dilatation was recognized a long time ago and has recently been studied by Todd and Hisaw.

The presumption might be that the mothers die from sapræmia after the deaths of the young, but it is hard to understand why mere resorption does not take place. Postmortem findings have been essentially negative.

An explanation should be offered as to why the symphysis does not dilate after the death of the fetus from the hormone injections and let the uterus rid itself of the dead (foreign) body. According to the work of Hisaw, already referred to, the pubic symphysis in the guinea pig dilates at about the time of parturition as a result of the combined action of the female sex hormone and the corpus luteum hormone. It is possible that a certain proportionate relationship is necessary between these two hormones for the act of dilatation and that the injection of excessive amounts of the female sex hormone upsets this fine adjustment with the result noted.

While it may be held that most of the mothers died from the effects of the injections, it is difficult to see why such a large proportion should, especially in view of the results in the second control series of non-pregnant females and males, when 6 animals received a total of 600 rat units of œstrin in 6 days with no ill result.

This point should be checked in some animal in which such marked pelvic changes are not necessary for the birth act.

Of course it may be considered possible that an optimum dosage might be found that would terminate pregnancy without the death of the mother.

While interruption of pregnancy in white rats after the fifth day was found impossible by Margaret Smith, when a maximum dosage of 80 rat units was used, it should be remembered that the corresponding stage in the guinea pig would be about 2 weeks. At this stage in the guinea pig we used as high as 150 rat units with positive results. It is quite possible that doses of 100 or more rat units

would interrupt pregnancy in the rat after the fifth day.

It is worthy of note that no apparent change takes place in the corpora lutea of pregnancy after the injections of œstrin. Possibly vital staining methods might have revealed some change. One might perhaps expect some attempt at a compensatory hypertrophy, but the bodies are homogeneous, and there is nothing to indicate that any new lutein tissue is being formed. Indeed, no constant microscopic change can be noted.

A study of the mammary glands during and after the injections was not made. Parkes and Bellerby injected œstrin in white mice during lactation and succeeded in bringing them into œstrus ahead of time, but no report on the histological changes in the mammary gland is made.

The general results of the experiments corroborate the findings of Smith and of Parkes and Bellerby and seem to warrant the conclusion that conception and normal pregnancy are not compatible with an excess of œstrin over corpus luteum hormone in the blood.

Courrier, however, does not believe that the termination of pregnancy is due to the destruction of any balance between the two hormones, but that it is caused by the muscular contractions of the uterus set up by the injections of the œstrin. If that were true, there would possibly have been some ruptured uteri in our animals in which the young died and the pubic symphyses did not dilate sufficiently to permit their extrusion. Also, Courrier's theory does not explain the prevention of conception, when œstrin is given just after copulation.

It must be admitted that the termination of pregnancy in these experiments may be due to some peculiar effect on the uterus or placenta, or both, that bears no relation to the corpus luteum. Loeb, in a recent paper, directs attention to his finding that ovulation could be called forth during pregnancy after complete extirpation of the corpora lutea and that maturation of ova is not interfered with during pregnancy. On the other hand his conclusion that removal of the corpora lutea shortens the anœstrous interval, would indicate that their presence delays the onset of œstrus.

CONCLUSIONS

1. Small doses of female sex hormone injected into female guinea pigs immediately after copulation for a period of several days will prevent conception in all cases in which an adequate dosage is used. The minimum dosage required is about 10 to 15 rat units.

2. Interruption of pregnancy in this animal when about 2 weeks pregnant can be accomplished in practically all cases with a total dosage of 100 rat units.

3. For animals pregnant about 4 weeks the gestation can be terminated by adequate dosage. An optimum amount for this stage is from 100 to 150 rat units. (With much larger doses the pregnancy is usually terminated by abortion, but the maternal mortality is high.)

4. In females pregnant from 6 to 8 weeks, injections of doses varying from 300 to 1,150 rat units invariably bring an end to normal pregnancy and almost invariably cause the death of the mother.

5. The death of the fetus after injections seems to be related to marked atrophic changes in the chorionic villi, resulting from pressure due to excessive hyperæmia or other cause.

6. The cause of the death of the mother is problematical.

7. The results with control animals indicate that the abortions and fetal deaths do not result from the injected material or from handling.

8. Administration of as high as 600 rat units of œstrin in 6 days to males and non-pregnant female guinea pigs is not incompatible with the life and health of fully grown animals.

9. The conclusion seems warranted that an excess of female sex hormone in the blood over the corpus luteum hormone is incompatible with conception and with the continuance of normal pregnancy in the guinea pig.

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THE DIAGNOSTIC VALUE OF UTEROSALPINGOGRAPHY IN PRE-ADOLESCENT OVARIAN TORSION[1]

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A STUDY of the available literature reveals that ovarian tumors in children are rare and that the correct pre-operative diagnosis is seldom made. One purpose of this communication is to describe a diagnostic procedure which led to an accurate pre-operative diagnosis in a case of torsion of a parovarian cyst in a girl of 9 years.

The patient was not in such condition as to require immediate operative interference. We felt justified, therefore, in taking the time necessary to make as accurate a diagnosis as possible before resorting to laparotomy. A review of the literature shows that a fairly large number of abdominal tumors of childhood are not emergency cases, thus establishing the practicability of the procedure which we employed.

The patient was a 9 year old girl, who complained of a mass in the lower abdomen. Two years previously, she had fainted on the street because of severe abdominal pain. Since that time she had had attacks of abdominal pain, sometimes accompanied by the vomiting of greenish yellow material. These attacks recurred at intervals of 1 to 2 months, and lasted from a few minutes to several hours. During the past 6 months the attacks had been more frequent, and the pain became localized in the lower right abdominal quadrant. About 2 months prior to admission her aunt noticed for the first time some abdominal enlargement. One month prior she had a more severe attack of abdominal pain, lasting several hours, and accompanied by vomiting. During the next few days the abdomen became visibly larger, and her physician was consulted.

Physical examination revealed a rather poorly nourished female child. The breasts were not developed; axillary and pubic hair was absent. Labial hair was present in more than the normal amount for a child of this age. There was a tumor occupying the mid-portion of the lower abdomen and extending to within 2 inches of the umbilicus. It was smooth, and the overlying tissues moved freely over it. It had a semi-solid consistence; no fluid ballottement could be demonstrated. No placental souffle or fetal heart sounds could be heard. Rectal examination revealed a tumor lying in the pelvis and seeming to move with the cervix. The bladder emptied completely on catheterization and contained a normal amount of urine. Blood counts and urinalyses were negative and X-ray studies failed to disclose any opaque mass, teeth, or bone. Our impression was that we were dealing with a uniform enlargement of the uterus.

Under gas-oxygen anæsthesia a pelvic examination was made. The vaginal orifice was small, barely admitting one finger. It was partially closed by an intact crescentic hymen. The cervix was palpated high in the vault posteriorly and in front of the cervix was a semi-fluctuant tumor. The mass filled the pelvis, extended to the umbilicus, and could be moved but slightly. Under aseptic precautions 3 cubic centimeters of iodized oil (lipiodol) was injected into the uterine cavity, as the child lay on the cystoscopic table, and an X-ray film was exposed. Two additional cubic centimeters of the iodized oil was then injected, making a total of 5 cubic centimeters and a second film was exposed. The roentgenogram showed a triangular uterine cavity of normal capacity for a child of this age; the cornua appeared to be somewhat enlarged. The uterus was displaced toward the right. The right tube was elevated, abnormally long, and was observed to describe a spiral. Free lipiodol was seen about the fimbriated extremity of the tube at a point corresponding to the upper limit of a faint shadow cast by the tumor mass. Evidently the right tube was attached to the tumor mass and was being pulled up into the abdomen by it. The left tube was elongated, extremely tortuous, and doubled back on itself so that the fimbriated extremity was pointing toward the uterus. There was free lipiodol about its distal extremity.

On the basis of these findings a diagnosis of torsion of a right ovarian cyst was made. Inasmuch as the child was somewhat dehydrated, and since her condition was not such as to demand immediate operation, forced fluids were instituted and she was sent home for a 15 day rest.

Operation. Under gas-oxygen anæsthesia the abdomen was opened through a central incision, and a bluish cystic mass was seen, occupying the mid-portion of the abdomen and pelvis. There were fairly organized adhesions to the colon over the entire extent and a few to the small bowel. After the adhesions were freed the tumor was seen to be a cyst of the right ovary with torsion of the pedicle, the pedicle consisting of the fallopian tube, thrombosed veins, and part of the broad ligament. It lay anterior to the broad ligament, with the pedicle twisted three complete turns in a clockwise direction. The pedicle was clamped and the tumor was delivered. The left ovary was about 2.5 centimeters in diameter and appeared to have multiple cysts throughout. A section was excised for examination and the

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abdomen was closed. The child made an uneventful recovery and was sent home on the tenth day. The report of the pathologist, Dr. Walter Simpson, was as follows: "Gross pathology: monolocular parovarian cyst 13 by 10 by 8 centimeters, weight 452 grams. The wall was reddish-purple in color, due to hæmorrhagic infarction, caused by twisting of pedicle. The attached fallopian tube also showed hæmorrhagic infarction. A small piece of the ovarian tissue was examined microscopically and showed multiple immature follicles and small follicular cysts, most marked just beneath the serosa. The wall of the monolocular cyst showed diffuse, recent hæmorrhagic infarction, with early simple necrosis. The cyst was lined with low simple columnar epithelium. No evidence of malignancy was found."

In establishing the pre-operative diagnosis, several possibilities were considered. Among these were: gynatresia (1), sarcoma of the uterus (1, 26),[1] sarcoma of one ovary (34), dermoid of the ovary, some anomaly of the bladder, and pregnancy.[2] Our attention had been called to the work of Heuser who first suggested the use of lipiodol in the diagnosis of early pregnancy. He stated that it would not produce abortion, and it was not dangerous to use. He described the picture produced in an early pregnancy. We did not follow his suggestion of producing pneumoperitoneum first, nor the technique of McCready and Ryan in taking a stereoroentgenogram. Had we followed these precautions we could, no doubt, have demonstrated the torsion of the tube very well. As it was, our findings left no doubt that we were dealing with a tumor of the right ovary and that the right tube, describing a spiral, was intimately connected with it. While the use of iodized oil in differential diagnosis of pelvic conditions is said to be not without danger (4, 11, 14, 18, 32), it has passed the experimental stage and its value is attested by many excellent articles (6, 8, 9, 16, 17, 19, 24, 25, 27, 28, 30, 37, 38). We feel that this case illustrates a condition in which the differential diagnosis was of great importance, and could only be made by the injection of some opaque medium and radiographic study.

We allowed a period of 17 days to elapse between lipiodol injection and the operation, feeling with Anspach and Hirst that it is safer to wait for some time following the injection before operation. It was felt, moreover, that a more severe reaction might be experienced in a child than in an adult, in the absence of any literature on the subject. As a matter of fact the child had some abdominal rigidity and pain for 2 days following the injection, unaccompanied by a rise in temperature.

Torsion of the uterine adnexa before puberty is an extremely rare condition, judging from the few cases reported. Smith and Butler reviewed the literature from 1900 to 1921 and were able to collect 25 cases. They also reported one of their own. We have reviewed the literature from 1920 to the present date and have collected 25 cases, abstracts of which follow. These cases seem to fall conveniently under three headings: (a) torsion of abnormal adnexa, (b) torsion of normal adnexa in abnormal situations, (c) torsion of apparently normal adnexa normally situated.

Torsion of abnormal adnexa. The torsion of abnormal adnexa is not hard to understand. Jellett (36) says that any tumor of the ovary which is not bound down by adhesions and which has a definite pedicle may undergo rotation. This is by no means a rare condition in adults. A. Martin (33) reports that 5 per cent of his cases have undergone torsion; B. Kustner (33) reports 47 per cent; and Stein (36) gives from 8.5 per cent to 15 per cent.

One anatomical condition favoring torsion is a freely movable tumor with a well-developed pedicle, presenting smooth rounded surfaces. A large cystic ovary, which by its weight has pulled upon its attachment, will produce for itself a well-developed pedicle, and will acquire free mobility. Conditions being favorable to torsion, this accident may occur through the action of one or several causes. As the tumor grows it rises out of the pelvis very quickly in children (23), but during its early development it rests upon the pelvic walls. The dorsal and lateral surfaces are compressed by the contact with the bony pelvis while the ventral and medial surfaces develop. This, coupled with the shape and tilt of the pelvis, tends to cause rotation toward the midline (2). The explanation of Kustner's law, which states that tumors of the

[1] Lewis Schiffey (34) states that in children sarcoma varies from 18 to 25 per cent of all ovarian neoplasms. They produce a rapidly growing, freely movable pelvic or abdominal tumor.

[2] De Lee (De Lee's Obstetrics, p. 2) quotes Bodd as saying that girls of 9 and 10 years have borne children.

right side usually rotate from right to left and tumors of the left side rotate from left to right, is no doubt based on these anatomical conditions (36).

Among other factors which may enter into the development of torsion, Kohler quotes Sellheim as saying that the inertia from a uniform twisting motion of the body may be transmitted to a tumor and cause it to undergo torsion on its pedicle. This is most apt to occur to a mass which is freely movable, its surfaces smooth, and its contents fluid. Torres reports a case of torsion probably caused by a fall from a chair. Anspach (3) mentions the effect of some sudden unusual exertion, such as lifting or straining at stool, which abruptly increases intra-abdominal pressure, thus rotating the tumor. Peters finds that during a coughing spasm the small intestines are thrown down into the lower abdomen suddenly and with considerable force. If an ovarian tumor should be present, the impact of the intestinal mass against the tumor would be a factor in producing torsion. Other writers suggest a sudden decrease in the pressure as the emptying of an overdistended bladder, and in the adult the emptying of a gravid uterus, as being a factor in producing torsion.

Payr (39) offers a hæmodynamic theory. He experimentally induced torsion in different organs by increasing their venous pressure. He showed that if the veins of a pedicle become engorged, torsion may go on without any other additional force. It is well known that veins of pedicles are longer than the arteries associated with them, and that their walls are thinner, and stretch easier than do the more muscular walls of the arteries. A slight pressure on a pedicle insufficient to interfere with the lumen of the artery may be sufficient to compress the veins, bring about their dilatation and elongation, and cause them to describe a spiral around the more fixed parts of the pedicle, namely, the connective tissue and the artery. Such spiral turns of the veins may, according to Payr, carry the cyst, if not too large, around the pedicle and bring about torsion.

While tumors of the ovary in children must comprise a very small percentage of all ovarian tumors, their number is by no means negligible. Weil (10), in 1904, collected 60 cases of ovarian tumors in children up to 10 years of age, which he placed under the following classifications: dermoids, 21, or 35 per cent; cysts, single or multilocular, 19, or 31.6 per cent; sarcoma, 15, or 25 per cent; carcinomata or papillomata, 8, or 8.4 per cent. To these Downs added 26 cases comprising: simple cysts, 2; dermoids, 8; malignant tumors, carcinoma, or sarcoma, 16.

Downs feels that the higher percentage of malignancy reported in the later cases can be accounted for by the more careful histological study to which such growths are subjected. Howard Kelly (Keating's *Cyclopedia of Diseases of Children*) collected 126 cases of ovarian tumors in children which he classifies as follows: cystic tumors—adenocystomata, unilocular, dermoid (cysts); solid tumors—sarcomata, carcinomata.

Downs believes that even in the fetus simple cysts may reach considerable size. Findley quotes Dornas' report of finding proliferating cysts in the ovary of a 7 month fetus, and states that Boulard found numerous cysts in a stillborn child. According to Downs the most common complication of tumors is torsion, and they are most apt to occur in growths of moderate size.

Torsion of normal adnexa abnormally placed. This, according to Heineck, occurs only as a complication of congenital hernia of the inguinal type. In 1912, he collected from the literature of the preceding 20 years 5 cases of torsion of the ovary and 18 cases of torsion of the ovary and tube in hernial sacs. It is an accident of infancy. It is a true torsion and is to be differentiated from strangulation of the contents within the sac. The youngest patient was 1 month of age, and the oldest case was 5 years old. The majority are in their first year. It is of about equal frequency on each side. Pathologically, the same changes occur as in torsion in the abdomen. Damianos (35) thinks that Payr's theory explains their occurrence. Auvray says that the spiral course of the tube, normal in fetal life may persist. This could be a predisposing factor. The clinical picture is that of an atypical strangulation of an omental or intestinal hernia.

Obstipation is usually absent, and the general condition in most cases is not serious. There is not the same tendency for the case to become progressively worse as in intestinal hernia.

Torsion of normal adnexa normally placed. This condition in children is more difficult to explain. In fact, it seems impossible for it to occur in an entirely normal ovary. We must broaden our classification to include those organs which, while they are not abnormal histologically, do present abnormal anatomical characteristics. As Smith and Butler (14) point out, an ovary may be normal histologically and yet be mechanically predisposed to torsion. These mechanical or anatomical abnormalities would include an excessively long mesovarium, a long tube, or an unusually large heavy ovary, which would pull away from its attachment sufficiently to form a pedicle. Also Auvray's premise (that the spiral course of the tube, normal in fetal life, might persist in extra-uterine life) could be a predisposing factor. Among the cases so classified, Smith and Butler place their own and four others. In their case the ovarian tissue was destroyed, being replaced by partly organized clots, and there was a small cyst present. Of the four which they abstracted they question the propriety of so classifying two in which the ovaries were said to be the size of a lemon. No histological study was done in either case. In the two remaining cases, one (Johannson) stated that at the time of operation the ovary was enlarged four or five times and that the pedicle was twisted once. The mesovarium was unusually long. Microscopically the ovary was completely infarcted and no microscopic details were discernible. The other case (Cassidy and Norbury) was one in which the left ovary and tube and the corresponding broad ligament were twisted. No mention is made of the size of the ovary. The histological examination showed only extreme vascular engorgement. (Fiolle's case showed a mass the size of a tangerine. On histological study it was impossible to identify any ovarian tissue, the mass being composed wholly of necrotic tissue with leucocytic infiltration.) Cohen's case showed a bluish black sausage shaped mass which included the tube; no ovarian tissue could be identified. The mass was composed entirely of blood cells with an occasional thin strand of connective tissue.

That the correct diagnosis in cases of torsion of the uterine adnexa in children is seldom made is shown by the following summary of pre-operative diagnoses in the cases collected by us:

	Cases
Appendicitis	9
Some pathological condition of the bowel	4
Some surgical condition of the adnexa	3
Encysted fluid in the abdomen	1
Suspected torsion of an ovarian cyst pedicle	1
Ovarian tumor	1

Due to the relative infrequency of this accident it is, doubtless, seldom considered as a possibility. With the condition in mind, however, there has been little to guide one in confirming the diagnosis. The factors which determine the violence of the systemic disturbance are the degree of torsion, and the rapidity with which it occurs. We can expect symptoms varying from very slight abdominal pain, and the appearance of an enlarging, painless abdominal tumor to symptoms of a severe abdominal crisis, with shock, rapid pulse, and severe gastro-intestinal disturbance. Ovarian tumors in children rise out of the pelvis early in their development, so that if a mass is palpable, it may be mistaken for the kidney or the spleen. Downs says that by rectal examination the cord-like pedicle can be felt. This is not mentioned by other writers where a rectal examination was made, and we were unable to feel the pedicle in our case. Koucky says that in torsion of an ovarian pedicle there is pain referred to the outer aspect of the upper third of the thigh on the affected side. X-ray alone is helpful in cases of dermoid cysts where there is enough calcium deposit to cast a shadow. Marshall found that in a series of 100 cases of dermoid cysts examined at the Mayo Clinic, 26 per cent showed calcium deposit, and that in a series of 415 cases of dermoid cyst the correct pre-operative diagnosis was made by X-ray demonstration of teeth shadows in 3 cases.

Realizing the obstacles in the way of correct diagnosis, we feel that lipiodol injections in those cases which do not present serious

symptoms are quite as justifiable and helpful in children as in adults. If the method is used, the amount of opaque substance injected must be adapted to the size of the uterine cavity of the patient. We would expect no untoward results from this procedure, and the value of the information gained would more than compensate for any inconvenience which the examination would cause the patient.

TORSION OF ABNORMAL ADNEXA

CASE 1. Reported by Erwin Baumann (40). A girl of 14 years, who never had menstruated, gave history of cramps in abdomen. She experienced sudden cramps and vomiting after coasting. A round tumor reaching to the umbilicus was found. Turning of cyst was suspected. Pulse was 100 and temperature 99.1 degrees. At operation 320 cubic centimeters of serous bloody fluid was found in the abdomen. A cystoma, twisted twice 180 degrees was removed. There was cystic degeneration of long pedicled ovary, which weighed 750 grams. It showed hæmorrhagic infarcts, multilocular cysts, and solid dense spots. Patient recovered.

CASE 2. Reported by Delmas (46). A girl aged 13 years had a normal temperature and pulse of 80. Her general condition was good. She had a sudden sharp pain in suprapubic region, localized at first to the left of the median line, and then became generalized. This was soon followed by vomiting. A median, infra-umbilical mass was palpated. It was hard and taut, but not painful. Pre-operative diagnosis was as follows: (a) volvulus of small intestine, (b) hæmatometra or left hæmatosalpinx. At operation a twisted cyst of the left ovary was found. The cyst was composed of three pockets, one cystic and filled with bloody fluid, two dermoid in character. The tube and round ligament were involved in torsion. Patient recovered.

CASE 3. Reported by O. Wallerstein (60). A 9 year old girl experienced violent pains in the pelvic region, accompanied by vomiting and constipation. Her general condition was good. Rectal temperature was 38 degrees C. There was "defense musculaire" in left inguinal region. Pre-operative diagnosis was appendicitis. Operation was performed. The peritoneum was dark looking and contained free bloody serous fluid. The appendix was free. The twisted cyst of the left ovary was the size of a hen's egg and totally infarcted. The girl recovered.

CASE 4. Reported by J. Gainza Eseverri and A. Metraus (47). Baby girl aged 2 years had had digestive disturbance since birth. The present attack was ushered in by vomiting with continued nausea. There were several acid, seromucous, greenish stools. The child had no fever. There was smooth orange sized swelling in the midline of the hypogastric region, having clearly defined boundaries, movable in all directions. The pre-operative diagnosis was: (a) serous cyst of mesentery, (b) sarcoma of left ovary. At operation a cystic tumor of the left ovary with the tumor twisted three times on its pedicle was revealed. Patient recovered.

CASE 5. Reported by N. Holtmann (50). A girl of 15 years was first operated upon for acute appendicitis. One month later the pain recurred. The child was underdeveloped for her age. She had not menstruated. Her temperature was 37.3 degrees C. The tongue was dry. There was tenderness to pressure in hypogastric region. On rectal examination a tender mass the size of an apple was discovered. Its form changed when the patient attempted to rise. Diagnosis was: (a) hæmatometra, (b) cyst. On operation a solid bluish-red tumor was found on the right in Douglas' pouch. It was about the size of a small fist and was twisted 360 degrees on its pedicle in a clockwise direction. The uterus was absent, though the left ovary, both tubes, and the vagina were present. Microscopic diagnosis showed dermoid cyst of the right ovary with hæmorrhagic infarction of the wall. Patient recovered.

CASE 6. Reported by V. Riche (58). A girl of 11 years whose general condition was good, who had a normal temperature and pulse of 80, had a sudden attack of pain in the right side with vomiting. She had experienced several previous attacks. There was a painful swelling about the size of a tangerine in the right side. The inferior pole corresponded to McBurney's point. Pre-operative diagnosis was appendicitis. At operation a cyst of the right ovary was found twisted two and one half times upon its pedicle in a clockwise direction. Histological study was not then complete. The girl recovered.

CASE 7. Reported by Y. Bourde (41). Girl 11½ years old had a sudden left sided abdominal pain. Her temperature was 37.5 degrees C; pulse 122. Her general condition was good. She had had three similar attacks previously. Palpation gave a fluctuating mass which measured 8 centimeters in height and 14.9 centimeters in breadth. Roentgenography gave a rather light but fairly clear shadow. Pre-operative diagnosis was not given. At operation there was found a large mucoid cyst of the left ovary which had passed over to the right side. Its pedicle was twisted exactly three times in a counter-clockwise direction. Right adnexa, uterus, and appendix were normal. The cyst which was removed weighed 800 grams. There was no microscopic report. The girl made a normal postoperative recovery.

CASE 8. Reported by Y. Bourde (41). Baby girl aged 20 months had been malnourished since birth. She also had enlarged liver since birth, which had decreased under specific treatment. Lower abdomen, however, continued to enlarge. This enlargement gave signs of free fluid in abdominal cavity. She had had an attack of violent pain in the right side of the abdomen. Pre-operative diagnosis was: (1) ascites, (2) cyst of mesentery, (3) dilatation of the colon. An enormous mucoid cyst of the right ovary was seen at operation. There was a pedicle twist of more

than two turns. Ovary was removed. She recovered after a stormy postoperative course. The cyst contained more than 2½ litres of mucoid substance. It was unilocular and showed intracystic hæmorrhage. There was concomitant appendicitis. Bourde also reports the case of a girl 15½ years of age who, at operation, disclosed a cyst of both ovaries and the acute attack of abdominal pain seemed to have been due to an intracystic hæmorrhage with distention of the sac. Both ovaries were removed and she recovered.

CASE 9. Reported by J. Fiolle (13). A girl of 10 years of age had sudden violent abdominal pain. Her temperature rose from 98.8 degrees in the morning to 100 degrees in the afternoon. Her pulse rate increased from 80 to 120 in this time. The entire abdomen was contracted and painful, but the contraction was most marked on the right side where the abdomen was of woody consistency. The maximum pain was in the right iliac fossa. Pre-operative diagnosis was appendicitis with probable perforation. When the peritoneum was opened blood escaped from the cavity in a stream. The appendix was somewhat congested, and was removed. The hæmorrhage was then seen coming from the true pelvis. The right adnexa had undergone torsion, the pedicle being twisted in a clockwise direction. The involved tissues were ligated and removed. The hæmorrhage was completely controlled and the wound was closed.

Histological examination showed that the mass was almost wholly formed of necrotic tissue with leucocytic infiltration. Some epithelium, which appeared to belong to the tube, was found at several points.

CASE 10. Reported by Warren R. Rainey (57). Patient aged 2 years and 6 months was in poor condition. Temperature was 102.6 degrees; pulse 130. Respiration was rapid. Child had been ill 3 days with pain and tenderness in right side. During this time there had been a progressive increase in the severity of the symptoms, accompanied by increased pulse rate. On the third day a mass producing definite swelling in the right lower quadrant was observed. The child appeared septic, and there was muscular rigidity present.

When the abdominal cavity was opened, a small amount of blood escaped. A tumor the size of a fist was seen springing from the right ovary. The pedicle was twisted upon itself at the junction of the tube with the ovary. The involved tissues were removed. The patient recovered. Pathologist's report: "teratoma of the ovary. Simple dermoid cyst with hæmorrhage into the wall due to twisting of the pedicle."

CASE 11. Reported by W. W. Massey (23). Negress, aged 10 years, although normally developed had never menstruated. Previous health had been good. She was seized with cramps in the abdomen during the night. She appeared to be 7 or 8 months' pregnant and in labor. There was a smooth even enlargement of the abdomen, and a mass giving definite fluid fluctuation and a dull note on percussion could be made out. Pre-operative diagnosis of encysted fluid in the abdomen was made. A dark blue tumor was delivered through a median incision, and proved to be a right ovarian cyst with a twisted pedicle. It contained one gallon of straw colored fluid and some clotted blood. The patient was discharged from the hospital on the fourteenth day. She was married at 15 and was delivered by normal labor at 16.

CASE 12. Reported by Frank Halvestine, Jr. (48). A girl, aged 10 years, complained of pain in the right lower abdominal quadrant, accompanied by nausea and vomiting. She had had three similar attacks. The temperature was 100.2 degrees; leucocytes 14,600. There was tenderness and muscle spasm in the right lower abdominal quadrant most marked over McBurney's point. No mass was felt. A pre-operative diagnosis of acute appendicitis was made. At operation there was an escape of a moderate amount of bloody serum. There was an orange sized cyst of the right ovary, bluish black in color, and apparently undergoing gangrene. The pedicle was twisted twice. The right tube and ovary were removed. The patient recovered.

CASE 13. Reported by J. Morris (54). A girl of 4½ years was seized with sudden abdominal pain, intermittent in character, which grew progressively worse. At operation a cyst of the left ovary was removed which weighed 11 ounces. The pedicle was twisted three times in a clockwise direction. The child recovered.

CASE 14. Reported by P. Curtis (45). Baby girl of 3 years was admitted to the hospital in extreme abdominal pain. The attack came on very suddenly. The temperature and pulse were normal and the child had a normal bowel movement a few hours before the attack. There was a tumor mass above the pubes which felt like a distended bladder, but catheterization made no change in it. At operation a simple unilocular cyst of the left ovary was removed. It was the size of a large peach with a pedicle twisted upon itself several times. The child made a good recovery.

CASE 15. Reported by Harry L. Kincaid, and Edmond Andrews (51). Girl aged 4 years and 11 months had pain in the lower right abdominal quadrant, associated with nausea and vomiting. One week previously, she had been nauseated but had had no pain. The temperature was 99.2 degrees; pulse rate 102; respiration 26; leucocytes 16,100. There was a tender, palpable mass in the right iliac fossa about the size of an orange. A pre-operative diagnosis of ovarian tumor was made. A simple dermoid cyst of the right ovary with a twisted pedicle was removed at operation. There was hæmorrhage into the cyst walls.

CASE 16. Reported by Mark S. Ruben (59). Girl, aged 10 years, experienced sudden acute pain in the right lower abdominal quadrant accompanied by vomiting. Bowel movement was regular. Her temperature was 102.8 degrees; leucocytes 20,000;

Fig. 1. Shows the symmetrical enlargement of the lower abdomen, which extends to the umbilicus.

80 per cent polymorphonuclears. There was abdominal rigidity and tenderness to pressure. A preoperative diagnosis of appendicitis was made. At operation a hæmatosalpinx was found on the right. The tube was twisted two and one half times, and the ovary showed a hæmorrhage cyst. There was a large cystic ovary on the left. Right tube and ovary were removed. The child recovered.

CASE 17. Reported by Mark S. Ruben (59). Patient 7½ years old had pain in the left lower abdominal quadrant with vomiting. There was no abdominal rigidity. A soft globular mass was felt in the lower right abdominal quadrant. At operation an ovarian cyst was removed from the right side. It was of grape-fruit size with twisted pedicle. The girl recovered.

CASE 18. Reported by Mark S. Ruben (59). Girl, aged 14 years, had an acute attack of pain in the abdomen. She gave the history of a sticking pain in the right side for several years. A tense cystic tumor was felt in the midline of the lower abdomen, rising to two fingers breadth above the umbilicus. A large cyst of the right ovary with a twisted pedicle was removed at operation. The patient recovered.

Ruben also reports the case of a girl aged 4 years, who had three acute attacks of abdominal pain with fever and vomiting. She recovered spontaneously, but he feels that this was also a case of torsion.

CASE 19. Reported by W. M. Powell (56). A five month old baby girl had acute abdominal symptoms demanding operation. The uterus and appendages were so affected by torsion that it was necessary to remove them entirely.

CASE 20. Reported by E. Heinze (49). Child aged 6 years, whose previous history was negative, was taken suddenly ill with abdominal pains, which were more severe on the right side below the umbilicus. The child vomited once. Temperature on admission was 100.4 degrees; pulse 128. There was slight tension of the abdominal walls with tenderness on deep pressure over McBurney's point. Pre-operative diagnosis was appendicitis. At operation an egg sized tumor of the right ovary was found. Its pedicle was turned once to 180 degrees in a clockwise direction. The right ovary and ampullar part of tube were removed. Appendectomy was done. She recovered.

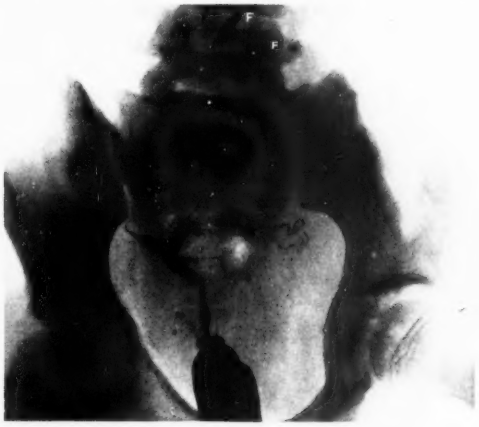

Fig. 2. X-ray plate taken after 3 cubic centimeters of iodized oil was injected into the uterine cavity. The body of the uterus is deflected toward the right. Both cornu are markedly developed. The right tube can be followed through one complete turn. The tube appears to be much elongated, and high up out of the pelvis. The fimbriated extremity is marked by the heavy deposits of iodized oil at *F* and *F'*. An oval shadow, cast by the tumor mass, can be made out. The left tube is much elongated and doubles back upon itself.

CASE 21. Reported by M. Pierre Laurent (52). A 7 year old girl had suffered from attacks of abdominal pain, coming on acutely, and at irregular intervals for a year and a half. The present illness was inaugurated by a very severe attack of abdominal pain, accompanied by vomiting 4 days previous to hospitalization. The child was prostrated. Her pulse rate was 130; temperature 38

Fig. 3. The tumor mass showing the large cyst with the pedicle (at the top) consisting of the right tube and part of the broad ligament.

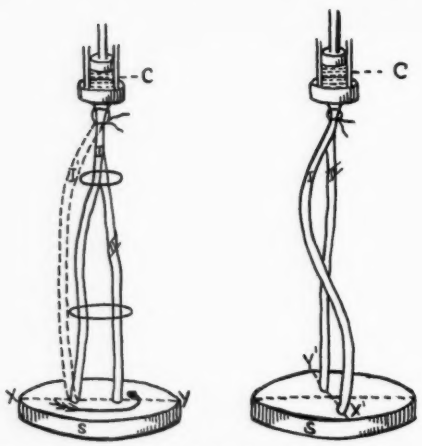

Fig. 4. Illustrating Payr's theory. *S*, Is a disc to which are attached two tubes, *I* is thin walled and represents the vein, *II* is thick walled and represents the artery. *II* is filled with water and tied off at both ends. Water is forced under pressure from the chamber *C* into the tube *I*. The tube becomes elongated *I'* and the disc is rotated as shown in the second drawing. (After Payr.)

degrees C. She had moderate abdominal distention, besides muscular rigidity and generalized abdominal tenderness. The pre-operative diagnosis was acute appendicitis with peritonitis, although the general picture was not considered typical. At operation a simple cyst of the right ovary twisted three times on its pedicle was revealed. The pedicle consisted of the right tube and a portion of the broad ligament. The involved structures were removed and the child made an uneventful recovery. No histological study was made.

TORSION OF NORMAL ADNEXA ABNORMALLY PLACED

CASE 22. Reported by Breteche (43). Patient was a child of 3½ months. Illness had an acute onset with vomiting, obstipation, and swelling in the right groin. Pre-operative diagnosis was strangulated inguinal hernia. Operation was performed and in the sac, instead of the gut, the right ovary and part of the tube were found. There were three complete turns of the pedicle of the adnexa. The diseased organs were removed, and the wound was closed. The child recovered.

CASE 23. Busch (44) reports a hernia in a girl 10 days old, containing an ovarian cyst, the pedicle of which had undergone torsion.

TORSION OF NORMAL ADNEXA NORMALLY PLACED

CASE 24. Reported by Morris Cohen (7). Girl, aged 13 years, who had never menstruated, gave an uneventful past history. The present illness had existed 4 days with symptoms of sharp pain in the lower right abdominal quadrant with some vomiting. She also complained of frequent and painful micturition. The right lower abdominal quadrant was very tender and rigid. No masses were palpated. A blood count showed leucocytes, 17,800 with a differential count of 89 polymorphonuclears and 11 lymphocytes. Temperature was 102.8 degrees F.; pulse 100; respiration 26. Pre-operative diagnosis was acute appendicitis. At operation a tumor mass was delivered which consisted of the right ovary twisted in a clockwise direction upon the tube and mesosalpinx. The appendix appeared to be inflamed at the tip and was removed. The adnexal mass consisted of a kidney shaped tumor 12 by 6 by 3 centimeters, along the concave side of which the uterine tube was attached. It was removed. Microscopically ovarian tissue could not be recognized, the mass being comprised of blood cells with an occasional strand of connective tissue. The patient recovered.

CASE 25. Reported by F. Neugrbauer (55). Girl, aged 6 years, was taken acutely ill. There was pain in the ileocæcal region without muscle rigidity. She had been vomiting. Her temperature was 37 degrees C. Pre-operative diagnosis was inflammation of the cæcum. She had had two previous attacks lasting 24 hours with sudden recovery. Operation disclosed a thin layer of clotted blood covering the omentum and intestines. The appendix was normal but was removed. The right ovary and tube were enlarged into a bluish red tumor due to engorgement with stagnated blood. The pedicle near the uterus was rotated around its own axis. There were no adhesions or other regions of inflammation. The right adnexa were removed and the patient recovered. The tumor was 5½ centimeters long, and its greatest circumference was 11 centimeters.

SUMMARY

1. A case of torsion of an ovarian cyst in a 9 year old child is reported which was diagnosed by uterosalpingography.

2. A review of the literature on torsion of the adnexa before puberty is presented.

3. All cases reported since 1920 to the present date are collected and classified.

4. The practicability of uterosalpingography as a diagnostic aid in certain of these cases is pointed out.

I am greatly indebted to Dr. Marshall M. Best, of Xenia, Ohio, for his co-operation and suggestions in studying this case. My thanks are also due Dr. Walter Simpson, head of the pathological department of Miami Valley Hospital, Dayton, Ohio, for his accurate and painstaking study of the specimen.

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CLINICAL SURGERY

FROM THE SURGICAL CLINIC, CHARITÉ HOSPITAL

THE SURGICAL TREATMENT OF TUBERCULOUS CAVITIES OF THE LUNGS WITH FILLING—"PLOMBE"

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THE method of obliterating cavities in lung tissue by inserting a filling between the wall of the thorax and the surface of the lung was originated by Tuffier. He used the patient's own fat for this purpose. However well founded the idea was, the results of such treatment were uncertain for several reasons. In the first place, emaciated tuberculous patients rarely have enough fat available to fill completely the large cavities which often remain after the diseased lung area is detached from the wall of the thorax. And, too, soft fat is not capable of resisting the pressure exerted on the rigid wall of the cavity.

Baer's technique was a decided improvement in the carrying out of Tuffier's plan. Instead of fat he used paraffin with a high melting point—a mixture which hardens at body temperature and so meets the mechanical requirements better. Sauerbruch was the first to carry out this operation in a large number of cases. A number of difficulties were encountered at first in the development of Baer's technique, and only recently with increasing experience have more definite indications been worked out for its use and have the technique and after-treatment been improved.

On the whole the method is used only in the surgical treatment of cavities. Complete obliteration of the pleural space is even more necessary in this method than in thoracoplasty. Obliterating material that is placed on the delicate, non-adherent pleura descends through the force of gravity, and thus may tear the parietal pleural and penetrate the free thoracic cavity. It is therefore imperative that pneumothorax be applied before operation is undertaken. Often this is the only way of determining the presence and extent of adhesions. Another essential to good results is that the wall of the cavity be strong enough to withstand the pressure of the paraffin, which may be sufficient to break down the layer of lung or connective tissue between it and the cavity, if the layer is thin. The obliterating material then would break into the cavity—a most dreaded complication—and lead to serious irritation there. If severe infection does not make immediate removal necessary, the paraffin is coughed up in small bits. Small hæmorrhagic infarcts which arise after the necessary pneumolysis stimulate the development of such areas of pressure necrosis over thin cavity walls. The infarcts may be attributed to the fact that the blood supply of the wall of the cavity is partly taken over by vessels that pass from the wall of the thorax through the pleural indurations to the lung tissue. It is known from experimental investigation (Schlaepfer) that extensive venous communications are present. In detaching the lung, the veins are torn and the interruption of the circulation leads to circumscribed areas of congestion and hæmorrhagic infarcts which can be demonstrated anatomically (Nissen). However, this danger of pressure necrosis is present only when the wall of the cavity is very thin, that is, when it is a part of the pleural induration. Often very hard or even calcified indurations make pneumolysis and therefore obliteration impossible.

Information as to the distance between the inner wall of the cavity and the surface of the lung can be obtained by physical examination, particularly by means of the roentgenogram in two planes or by means of stereoscopic pictures.

Two things must be considered in deciding whether this operation is indicated. First, if one half of the lung is involved and the other half is not in condition to bear total obliteration of the diseased side by thoracoplasty, then the cavity, which generally lies in the upper part of the thorax, can be filled in order to overcome the chief focus of dissemination of infection and danger of aspiration. It is not easy, as every one knows, to judge how much the sound side will stand. In addition to the physical findings, one must take into consideration age, general con-

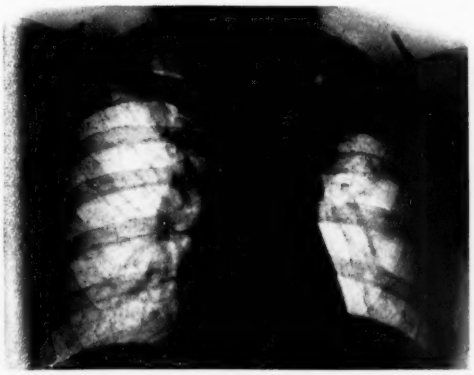

Fig. 1. Roentgenogram taken before operation, showing badly diseased left cavity, and slightly diseased right cavity.

Fig. 2. The same patient as shown in Figure 1 after the filling (plombe) had been placed in left lung.

tion, heart action, and other factors. The obliterating material excludes only a small amount of the breathing lung tissue, a factor of great value in such cases. At times it is justifiable to insert the paraffin on both sides. (Figs. 1–5.)

Compression of the lung by thoracoplasty is rarely indicated in patients more than 45 years of age. The indications for paraffin treatment can be considerably extended in such cases.

The point of preserving only functioning lung tissue is also a decisive factor in deciding whether the obliterating operation shall be used. If cavernous phthisis is present *only in upper part of the thorax* (Figs. 6–9) but the rest of the lung is free, the paraffin retracts the diseased focus and spares the normal tissue and so brings about healing. The objection might be made that in such cases a circumscribed thoracoplasty would accomplish the same thing. That is not true, however. In the first place, the purely mechanical effect of a partial plastic operation is generally insufficient and not comparable to the retraction brought about by the complete filling of the cavity. And, too, a circumscribed thoracoplasty over the upper lobe—and these cases are almost always in the upper lobe—means increased danger of aspiration of secretion into the breathing lower lobe. The fact that the part of the chest wall is deprived of its bone causes paradoxical respiratory movements at first after the operation and experience has shown that this means great danger of aspiration. In the obliteration treatment, for which it is necessary to remove only a short piece of one rib, the normal movements of the wall of the thorax are preserved. Aspiration was feared at first, but it is now known that it practically never occurs.

Another indication for paraffin treatment is the presence of severe recurrent hæmoptysis (Fig. 10). If life is threatened then, of course, the method of choice is artificial pneumothorax. If this does not bring good results, then collapse of the bleeding cavity should be brought about by filling. As operation in these cases is an emergency one to save life, the further extent of the disease is not taken into consideration.

Finally, the paraffin treatment can be used advantageously when, after the ribs are resected, a rigid system of cavities does not collapse completely. Then the effect is better and lasts longer than when extrapleural tamponing is done.

TECHNIQUE

The technique is as follows: Through a paravertebral incision, which we prefer to an approach from in front as recommended by Baer and others, the musculature is split and a piece of about 3 centimeters long is resected subperiosteally from the third or fourth rib (depending on the position of the cavity), near the angle of the rib (Fig. 11). Great emphasis must be placed on careful hæmostasis in the sectioned muscles. The finger is introduced carefully between the pleural induration and the wall of the thorax in the layer in which the finger finds the least resistance (Fig. 12). No strictly anatomical instructions for this can be given. The direction in which to make the dissection between intrathoracic fascia and thoracic wall is of little value as the induration generally makes impossible any differentiation between the layers.

As a rule the pneumolysis is made between the two folds of the pleura. If the right layer, that is, the least resistant one, is found, generally it is

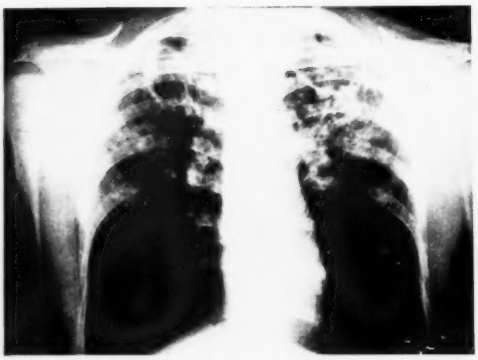

Fig. 3. Patient with cavities on both sides, suitable for double filling.

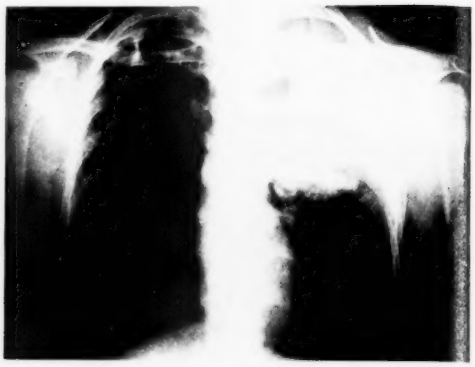

Fig. 4. The same patient as shown in Figure 3 after filling (plombe) on left side.

easy to dissect the whole cupola of the lung without difficulty. It is rarely necessary to dissect hard cords with strong pressure, scissors, or a knife. The extent of the pneumolysis is determined by the size of the cavity (Figs. 13–15). This is easily determined because the cavity (Fig. 16) can be palpated in the freed lung even through strong indurations. Usually the whole upper lobe should be dissected free from the vault of the thorax and the posterior and lateral parts of the lung be pushed down to the fifth and sixth ribs. Careful attention must be given to any possible tears in the lung. These are shown by the escape of air and can be seen readily on the coughing of the patient. If such tears are small they can be closed by suture and the insertion of paraffin risked. If, however, the lung tissue is extensively injured or the cavities have perforated, the perforations should not be sutured or the paraffin inserted but a thoracoplasty should be done. It is therefore advisable to extend the local anaesthesia, under which we always perform the operation, from the second to the sixth intercostal space. Hæmorrhage is generally slight even in the presence of a large cavity. Hæmorrhage can be controlled by putting in gauze strips for a short time. If the strips are moistened with 40 per cent alcohol solution the hæmostatic action is increased. After the gauze is removed the cavity is filled with a mass of paraffin which is of such consistency that it can be kneaded. Generally 500 to 600 cubic centimeters is sufficient. We have, however, used as much as 1,000 to 1,200 cubic centimeters successfully (Figs. 13–15), but we have abandoned this practice as several times the paraffin ruptured through the cavity.

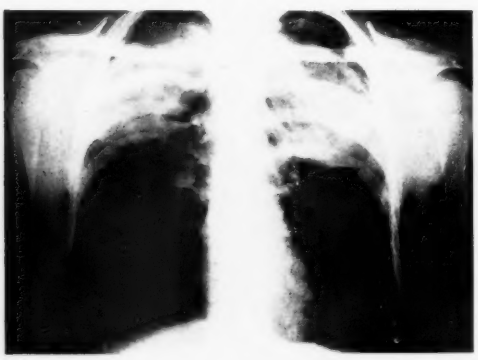

Fig. 5. The same patient as shown in Figures 3 and 4 after insertion of paraffin (plombe) on both sides.

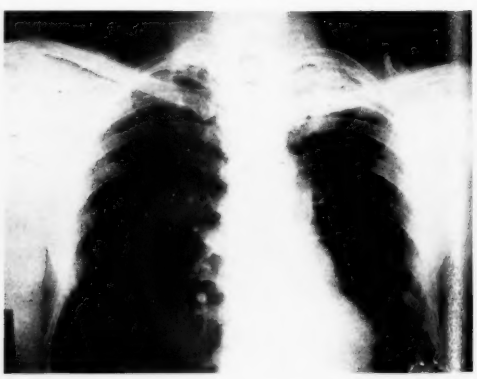

Fig. 6. Cavity system seen in left apex.

Fig. 7. The same patient as in Figure 6 after filling.

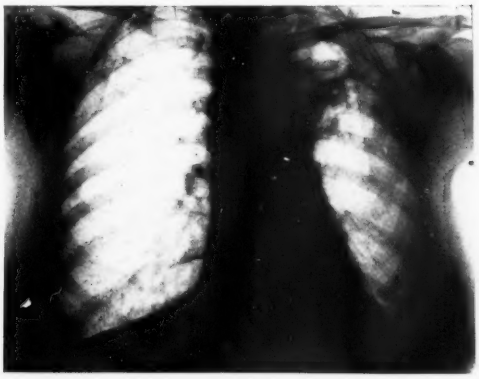

Fig. 8. A cavity in the left lung.

The material is prepared as follows: 75 cubic centimeters of paraffin with a melting point of 58 degrees is melted with 25 cubic centimeters of paraffin with a melting point of 43 to 44 degrees C. One cubic centimeter of bismuth carbonate and 0.05 cubic centimeter of vioform are added to a small amount of this mixture. Uniformity is obtained by stirring the mixture for ½ hour, gradually adding the rest of the paraffin. The mass is put into sterile glass vessels with tight covers and sterilized in a vapor sterilizer on 2 successive days for an hour each. Before using, the vessels are heated in a water bath and shaken to make the mixture uniform. The liquid is poured into sterile porcelain dishes in which it is allowed to cool until it is of the right consistency. When it is used, it must be homogeneous throughout, pale yellow, and soft enough to knead readily. When the cavity is filled to the level of the ribs with the paraffin, the resection opening is closed by pulling together the musculature of the adjacent intercostal spaces (Figs. 17–19). The operation is completed by suturing the muscles, fascia, and skin in layers.

For the first few days after the operation systematic attention must be given to the coughing up of accumulated material. Ordinarily the temperature rises correspondingly, though the wound is in perfect condition; the pulse may be 120 or more a minute. This intense reaction is the result of the sudden and strong compression of the tuberculous tissue. The toxins are pressed from the

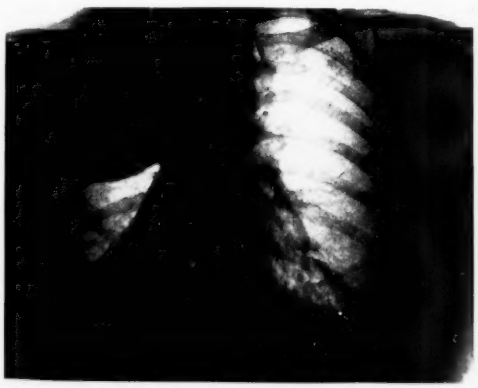

Fig. 9. The same patient as in Figure 8 after insertion of filling.

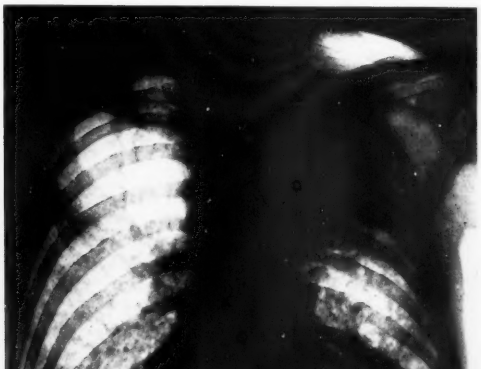

Fig. 10. The filling was put in the left lung because of the presence of severe hæmoptysis that threatened the life of the patient. The process in both lungs was spreading widely.

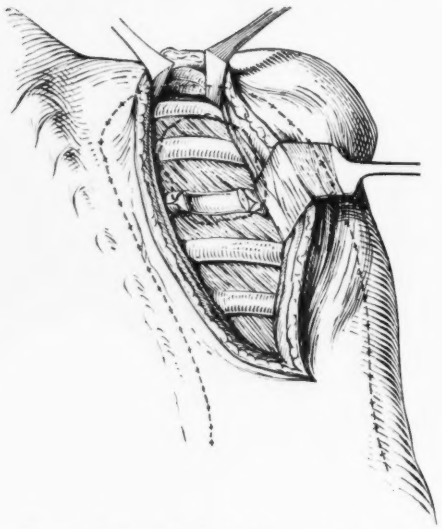

Fig. 11. Paravertebral incision exposing the ribs. About 3 centimeters of the third rib was resected. The margins of the cavity and of the lung are outlined by interrupted lines.

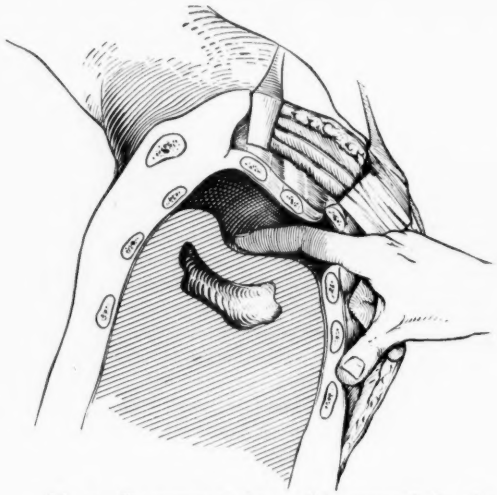

Fig. 12. Transverse section used in pneumolysis. Th finger is placed between the pleural induration and th thoracic wall.

diseased region into the circulation. They cause a sort of tuberculin action such as is not infrequently seen in pneumothorax and, in a milder form, in paravertebral thoracoplasty. While in the latter method retraction of the lung occurs gradually, this general reaction from the focus is not so marked as in the paraffin filling method.

On the second or third day the temperature ordinarily falls again, the pulse becomes less rapid, and expectoration, which was scanty at first, becomes more profuse, generally far beyond what it was before operation. Traces of blood, which are frequently seen and which are probably due to friction of the cavity walls or small hæmorrhagic infarcts, are not of serious importance.

If there is continuous fever and a feeling of pressure on the side operated upon and if the external wound does not show signs of inflammation, it suggests an exudate around the paraffin filling. Even small amounts of fluid cause considerable signs of pressure in the bed of the filling. Ordinarily the exudate becomes subcutaneous and can then be recognized by fluctuation. The effusion is emptied, as is a cold abscess, by puncture. Aspiration is continued for several days or even weeks, even when the exudate becomes purulent and contains pus bacteria.

When there was severe mixed infection of the bed of the paraffin, we frequently used to open the wound and remove the paraffin. But experi ence has shown than even with pus and bacteri present, puncture is usually sufficient. In recen years it has only rarely been necessary to remov paraffin due to infection of the bed of the paraffin

A much more severe complication, which oc curs much later, sometimes not until years have elapsed, is rupture of the paraffin into the thoraci cavity and bronchi. Small bits of paraffin are then coughed up. It is a striking feature that in spite of the communication between the bed of the paraffin and the bronchial tree the latter only rarely becomes infected. Even rupture of the paraffin is rare if only cavities with strong walls are compressed with moderate amounts of paraffin. The treatment in such cases consists in removal of the paraffin and extrapleural and paravertebral rib resection over the paraffin mass. The resection must be carried up to the first rib and down to the seventh or eighth rib, so the shoulder blade may lie in the defect in the wall of the thorax

Unfortunately, it is not always possible to obliterate the residual cavity at one sitting. Secondary operations make considerable demand on the already taxed strength of the tuberculous patient. Not infrequently the tuberculous tissue in the region of the fistula breaks down. The massive suppuration from the cavity opens upward and causes catastrophe. The few cases of death that have occurred after paraffin treatmen are to be attributed to this severe complication

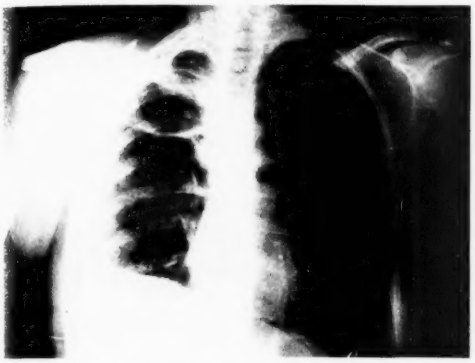

Fig. 13. A large cavity present in the right lung.

Fig. 14. Lateral view of same patient as shown in Figure 13 after a large filling in cavity.

The paraffin treatment may cause complications indirectly by constricting and distorting the chief bronchi at the hilus. This would cause interference with expectoration from the cavity region and also from the rest of the lung on that side. Congested secretion would disseminate the infection and large foci of liquefied tissue would develop. Fortunately this outcome, which cannot be foreseen when the paraffin filling is put in, is rare.

Occasionally the mechanical action of the filling material is insufficient. There are two reasons for this. Later, on clinical and roentgen examination, it is sometimes found that the paraffin has not compressed the cavity completely. In such instances another pneumolysis may be done and additional filling material is inserted. A second reason for insufficient mechanical action is that the upper lobe of the lung, particularly if there is a rigid cavity system and delicate pleural adhesions, may be pushed as a whole toward the hilus and downward without very much compression of the cavity. We have not seen this very often. It has occurred particularly when, for any reason, an artificial paralysis of the diaphragm has been produced beforehand. In such cases, if the pleural adhesions are delicate, the whole half of the lung moves toward the abdomen. In that case the yielding parenchyma is compressed to a certain extent by the paraffin, but the rigid cavity is not. Later operations do not affect this condition unless in the course of months the mechanical irritation of the paraffin makes the pleura firmer and

Fig. 15. Front view of same patient as shown in Figures 13 and 14.

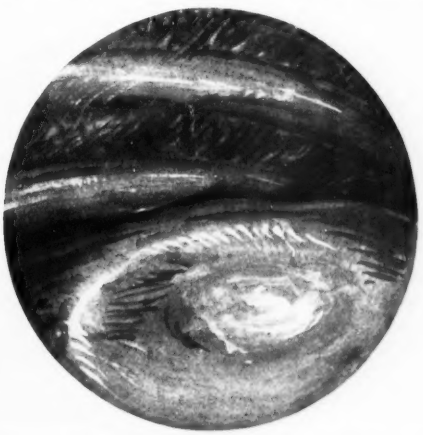

Fig. 16. Endoscopic picture after complete pneumolysis.

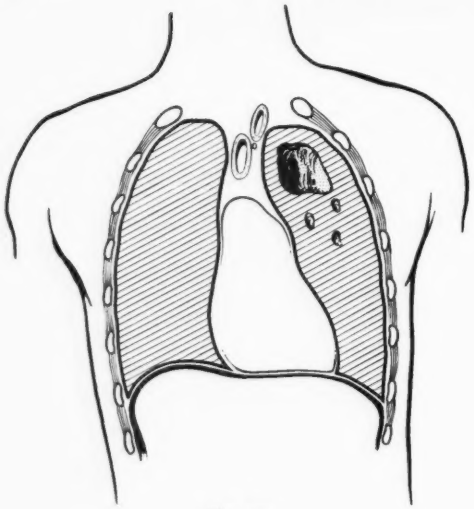

Fig. 17.

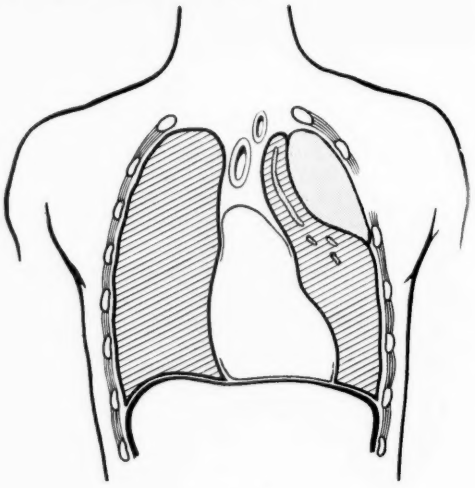

Fig. 18.

Figs. 17, 18, and 19. Sketches showing the effects of paraffin filling (plombe) on a cavity of the left lung.

Figure 17 shows the cavity; Figure 18 shows that the filling exerts lateral pressure from the side; Figure 19 that the filling exerts pressure from above.

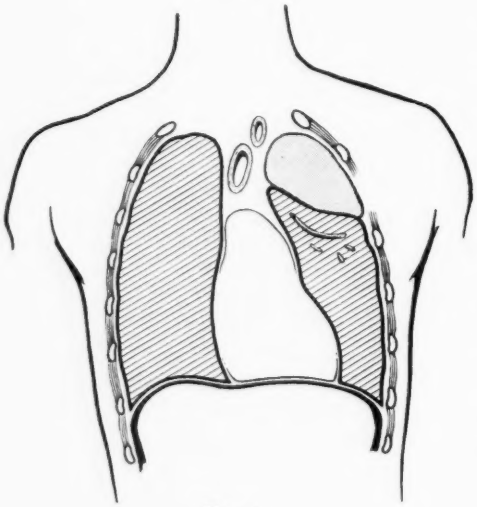

Fig. 19.

so the lung is able to offer resistance to the paraffin. If this happens the additional paraffin may later be inserted. The peculiar action which the paraffin exerts on the connective tissue of the lung and pleura produces a favorable late result. The irritation of the paraffin leading to the formation of indurations is particularly marked and valuable in the treatment of deep seated abscesses with a free pleural cavity. These same processes are seen in the filling of tuberculous cavities. Often the increased density of the connective tissue in the surrounding tissue can be demonstrated roentgenologically (Figs. 6, 11, 12, 13, 15, 16).

The advantage of the progressive cirrhosis for all tuberculous changes outside the cavity is obvious. But this good effect is of only subordinate importance as compared with the aid to the processes of healing which are brought about in the cavity by the paraffin. The retraction of the cavity leads to a decrease in secretion and the cleansing of the walls of the cavity even when the cavity is only partly compressed. The cleansed cavity wall is covered with epithelium from the bronchus and expectoration is reduced to a minimum. The cavity as a source of infection is obliterated.

Of course the filling is a cure only to the extent that the cavity has been obliterated; the tuberculous process must still be treated and conservative measures must be used—climatic treatment must be continued after operation.

Frequently filling of the cavity is done when total thoracoplasty cannot be carried out on account of local changes or the general condition of the patient. The results depend entirely on the condition of each patient. The operation in itself is almost free from danger, with practically no mortality for the first few weeks. Our statistics show that death occurs in only 2 to 3 per cent as a result of complications directly due to operation.

FROM THE SURGICAL CLINIC, LENOX HILL HOSPITAL

RESECTION OF THE THORACIC PORTION OF THE ŒSOPHAGUS FOR CARCINOMA

CARL EGGERS, M.D., F.A.C.S., NEW YORK

AT THE present time the great majority of patients with carcinoma of the thoracic portion of the œsophagus who come under observation have to be rejected for radical operation because of their poor general condition or of a local lesion too far advanced to be removable. Only a very small percentage may be directly accepted for operation, or may be put into better condition for operation by relieving complications and building them up. For these reasons progress in the surgery of the œsophagus, especially in cancer of the œsophagus, has been slow.

The results of operation in this small remaining group of cases have not been very satisfactory partly due to the fact that the operation is technically difficult and, as an occasional operation in the hands of a surgeon not thoroughly familiar with intrathoracic surgery, has yielded a high mortality, and partly due to the fact that at operation it is frequently found that the condition is inoperable.

There are certain definite reasons why surgery to date has not been able to combat this condition more successfully.

1. The patients are usually of advanced age, more often men in whom definite senile changes have taken place in other organs. They are frequently suffering from emphysema, bronchitis, myocarditis, arteriosclerosis, or nephritis. Even a much simpler operation than resection of the œsophagus in such patients would be associated with considerable risk. To subject such patients to an extensive operation which involves opening the thorax widely with the associated respiratory and circulatory disturbance is manifestly unjustifiable and can lead to no good. They would promptly succumb to shock or die as the result of a complication, either infection, pneumonia, pneumothorax, or a combination of various factors.

2. The lesion is situated in the deepest portion of the thorax where access is difficult, and where it is surrounded by vital organs, disturbance of which may lead to serious difficulty or complications. Opening of the thorax in itself involves physiological problems affecting the circulation and respiration, and steps have to be taken to guard against trouble. Technical skill, judgment, and resourcefulness have to be exercised in all these operations.

3. Cancer of the œsophagus though formerly frequently pictured as a rather benign epithelioma has been found to be a cancer just as malignant as other types of cancer with the same tendency to spread by direct extension and along lymph channels. As it spreads through the wall it involves the surrounding structures and interferes with their function. If adhesions to vital organs, as for instance the aorta, have taken place, operative removal may be impossible. Cancer patients who have reached the stage of emaciation or cachexia are always poor risks, no matter where the primary lesion is situated. In cancer of the œsophagus this is true to a greater degree because of the surrounding vital structures and the physiological disturbance which accompanies their involvement.

4. The patients have usually lost weight when first seen by the surgeon. Unfortunately, at the present time cancer of the œsophagus is rarely recognized until it produces obstruction with the attendant nutritional disturbance and loss of weight. This factor, added to those already mentioned, adds greatly to the risk of the operation. It is well known that there are many difficulties connected with the early diagnosis of this condition and that symptoms are frequently entirely overlooked until obstruction occurs. When we realize that obstruction always means advanced disease, with all its attendant difficulties and that at this stage the lesion has become adherent to surrounding structures and is difficult or impossible to remove, then the importance of early diagnosis at once becomes apparent.

From these observations it will be noted that the first consideration in determining operability is a patient in fair general condition with a local lesion not too far advanced.

Fig. 1. Showing position of body and line of incision.

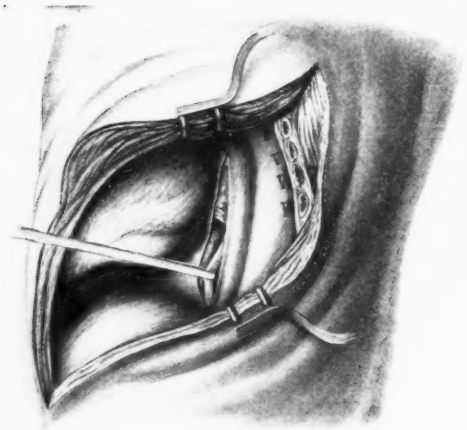

Fig. 2. Chest opened. Mediastinal pleura split and œsophagus isolated.

Fig. 3. Incision of pleura above arch of aorta wit isolation of œsophagus at this point.

The general condition of the patient can be determined by observation and examination, and steps may be taken to improve it.

The local condition, meaning the extent of the lesion, and whether it involves the surrounding organs or has developed metastases, can be determined only approximately in advance. Not until the thorax has been opened and the tumor actually exposed can one say with reasonable certainty that it is removable. Even then when the tumor has been almost freed one may have to discontinue the operation because separating the tumor still farther may mean certain death from hæmorrhage or infection.

PREPARATION OF PATIENT

Given a patient with a carcinoma of the thoracic portion of the œsophagus, a patient who seems a fair surgical risk, what is the best procedure to follow? He should be put into as good general physical condition as possible in order to be able to combat shock and infection. He must rest a great deal though he should be allowed out of bed to prevent congestion of organs. The circulation should be improved by the administration of drugs and perhaps by bathing and light massage. As there is usually loss of weight, every attempt must be made to prevent additional loss or preferably to bring about a gain in weight. This is a very difficult problem. Usually there is œsophageal obstruction of some degree, and a gastrostomy should be done at once, and the patient given from 6 to 8 ounces of fluid food every 2 hours. It should consist of anything which can be given through the tube—milk gruels, butter, fruit juices, raw eggs, beef juice sugar, and thick cereal soups. Even then th patient often continues to lose. Everything h is able to take by mouth he should be permitte to take, as the admixture of saliva is beneficia It will be found that after the establishment of gastrostomy, normal swallowing will often becom partially re-established, and patients should b encouraged to take food the normal way as i tends to better digestion and upbuilding.

Water should be given by mouth at all time unless complete obstruction is present when i may be dangerous by producing aspiration fro overflow. Water helps keep the mouth clean an also cleanses the carcinomatous ulcer in th œsophagus, preventing absorption therefrom an reducing inflammatory reactions.

Considerable attention must be given th mouth in all these patients, especially those wh do not masticate and have taken only milk an other fluids, as they have infected deposits abou their teeth. The latter must be cleaned, cavitie must be attended to, and mouth washes used. A clean mouth helps the immediate improvemen of the patient and tends to guard against me diastinal infection at the time of operation.

The morale of the patient is usually low and friendly hopeful attitude toward them is of value

Carcinoma of the œsophagus is usually a slo growing lesion, and one may devote a few week to the preparations for operation without muc danger of serious increase in the local lesion. O the other hand, if one considers that most of th lesions are quite advanced when they com under observation and show obstructive symp toms, it is wise not to delay too long befor

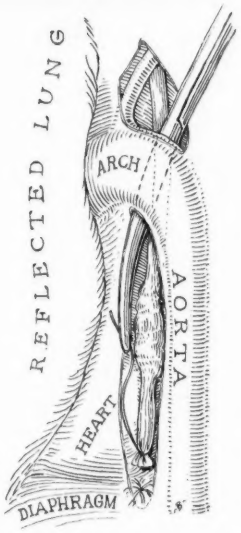

Fig. 4. Double ligation of œsophagus below the tumor with cauterization of stumps.

attempting the radical operation. Some improvement will usually be found with a properly functionating gastrostomy and attention to all the other measures mentioned.

The immediate preparation for operation does not differ from that in ordinary use. The entire neck, chest, upper abdomen, and left axilla have to be shaved. Feeding through the gastrostomy tube may be continued until a few hours before operation. If a residue remains in the stomach it may be evacuated just before operation. It is important that the upper œsophagus be empty to prevent aspiration. In complete or almost complete obstruction, the passage of a stomach tube down to the obstruction is advisable in order to evacuate the stagnated fluid.

A transfusion may be given if it is indicated, or at least preparation should be made for a transfusion during or immediately after operation.

A dose of morphine and atropine is given one half hour before operation.

ANÆSTHESIA

Anæsthesia has to be administered under a certain amount of pressure in order to avoid complete collapse of the lung. It is not necessary to keep the lungs fully expanded, as a matter of fact they have to be moderately collapsed in order to be able to work in the mediastinum. No special apparatus is required for this, but any

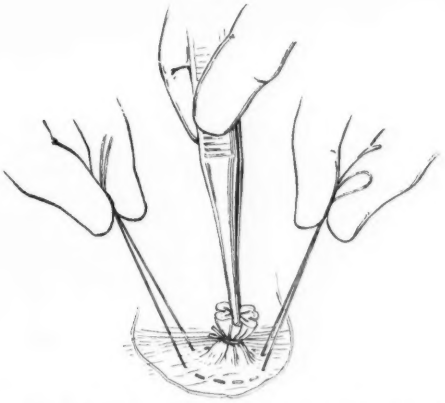

Fig. 5. Showing burying of lower stump into the stomach by means of a pursestring.

of the well known gas-oxygen-ether machines answer the purpose. With a snugly fitting mask one may vary the intrapulmonary pressure by increasing or decreasing the pressure in the bag, and the lungs may be kept moderately inflated or completely expanded as desired. The alternating collapse and expansion is at the same time an excellent stimulant for the heart, and may be resorted to at intervals during the operation, especially when shock is threatened.

OPERATION

The method in use on our service at the Lenox Hill Hospital is one developed and first performed by Dr. Franz Torek with slight modifications which have been added from time to time as they seemed indicated. It is the first real attempt at standardization of an operation for this troublesome and dangerous condition. Several patients have recovered from the operation and others have lived sufficiently long to encourage one in believing that the operation, if carefully performed in well selected cases, promises better results than have been obtained so far. The trouble is not with the operation but with the type of patient who is usually referred for operation.

The patient is placed on his right side with the right arm elevated and flexed above the head. The left arm is also elevated and may be either fastened to the head frame or, better still, it may be wrapped in sterile towels after it has been prepared and then entrusted to the care of a sterile nurse. Having the arm free makes it possible to rotate the body as needed. The back of the patient should be fairly close to the edge

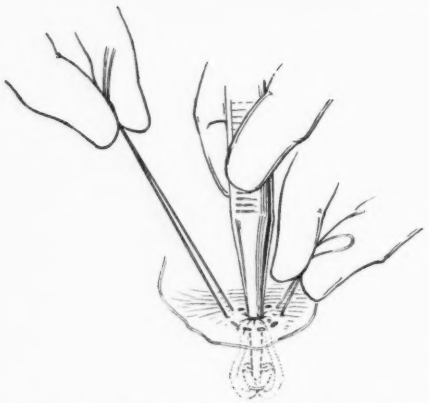

Fig. 6. Showing burying of lower stump into the stomach by means of a pursestring.

of the table, as there is always a tendency to roll forward, which makes access more difficult. The right thigh and leg are sharply flexed and the left leg is kept extended. This also helps to maintain the position of the patient (Fig. 1).

As the incision is to be very long, and it is necessary to have access to the neck, the field of preparation has to be large. The entire neck, the back, anterior and lateral chest, and upper abdomen, as well as the left shoulder and arm are thoroughly cleansed with alcohol and ether, and the area is then painted with half strength tincture of iodine. Sheets are applied in such a way that the arm projects and may be moved into any desired position, carrying along the scapula.

The incision runs midway between the spine and the posterior border of the scapula over the fourth, fifth, sixth, and seventh ribs and is then carried forward along the entire length of the seventh intercostal space. The muscles are then likewise divided. During this part of the operation many blood vessels are encountered and it is well to take time to ligate them all to avoid the loss of blood. The posterior ends of the four exposed ribs are now quickly divided, care being used to control bleeding from the intercostal vessels which may be quite troublesome. A good method is to use a strong curved needle with a double plain catgut suture and to catch muscle fibers together with the vessels. The pleura is now opened along the entire length of the incision. Frequently it is best to make the long intercostal incision first, spread the ribs apart as much as possible, and then, with a finger under the ribs as a guide, divide the seventh, sixth, fifth, and fourth ribs. This method is helpful in

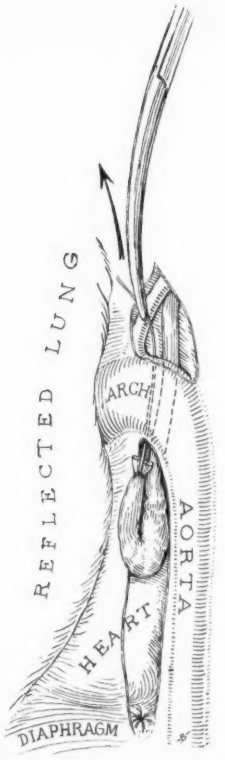

Fig. 7. Œsophagus has been divided. Upper end with tumor is being drawn upward behind the arch of the aorta.

controlling bleeding from the posterior ends of the intercostal vessels.

A rib spreader (a Balfour self retaining abdominal retractor serves this purpose well) is now inserted and the entire thoracic contents are exposed for inspection. By this time, unless pleural adhesions are present, the lung has collapsed somewhat and by gently displacing it forward the field of operation comes into view (Fig. 2). The aorta is the most prominent and is easily recognized by inspection and palpation. To the right of it the œsophagus is situated in the mediastinum. It can not be seen and neither can one feel it unless a large tumor which has involved the surrounding tissue acts as a guide to it. But such a case would be inoperable. To expose the œsophagus, an incision is made through the mediastinal pleura from the diaphragm to the under surface of the arch of the aorta. Without much difficulty the uninvolved portion of the œsophagus can then usually be

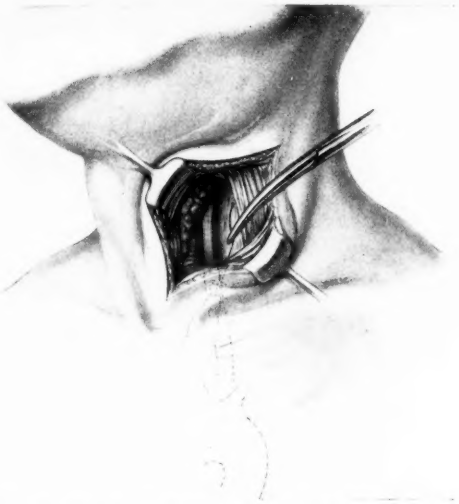

Fig. 8. Œsophagus has been isolated in the neck and is being drawn out of the wound together with the tumor.

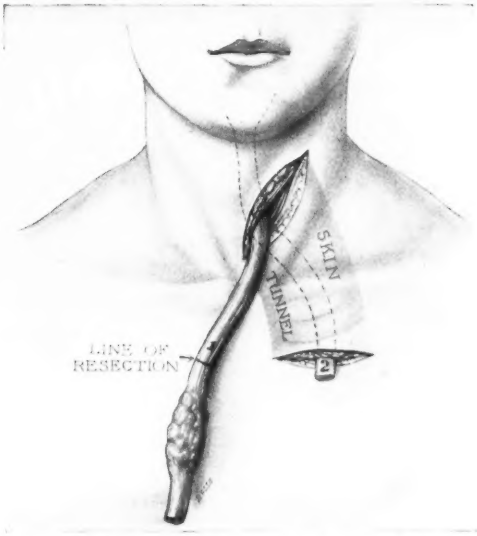

Fig. 9. Skin tunnel has been made from the lower end of the neck wound to about the region of the second intercostal space where a transverse incision has been made to which the œsophagus stump will be sutured.

isolated by blunt dissection with the finger. A tape is placed around it and gentle traction then enables one to pass the finger upward and downward in an attempt to free it completely and to palpate the suspected tumor.

Great care must be used doubly to ligate and divide all small vessels encountered, as bleeding with the attendant tissue infiltration obscures the picture and increases the difficulty. All cases which have come to operation at our hospital have had involvement of all the coats of the œsophagus, with adhesions to the surrounding structures. Whether in the face of extensive adhesions the operation should be continued must depend on the judgment of the individual surgeon. Patience and careful dissection will accomplish a great deal. If it is found that the tumor involves the wall of the aorta, it is evidently useless to proceed. On the other hand, adhesions to a bronchus or the opposite pleura have been successfully handled. Separating the tumor from its bed is always difficult, especially if it is situated behind the arch of the aorta. Vagus fibers have to be sacrificed and branches of the aorta may have to be divided to gain access. Should the opposite pleura be accidentally opened, a moist pack will temporarily avoid respiratory embarrassment. Later an attempt may be made to close the opening or one may succeed in re-establishing two pleural sacs by suture of the left pleura overlying the mediastinum. After completely freeing the œsophagus with the tumor, below and behind the arch, an incision is made in the pleura extending from the arch to the dome of the thorax (Fig. 3). With the finger the œsophagus is likewise isolated here, perhaps aided by a finger or curved clamp passed upward from below and behind the arch. These various manipulations produce considerable shock which at times is quite alarming. The best way to overcome it is to interrupt the operation from time to time for a few minutes and to use the interval to bring about complete expansion of the lung. We usually remove the rib spreader, take all pads out of the thorax, except perhaps one in the tumor bed, place a moist pad over the wound, and instruct the anæsthetist to increase the pressure and administer oxygen. The patient's color at once improves and respiration and circulation recover from the temporary depression. The next step in the operation is doubly to ligate the œsophagus below the tumor and to divide it with the electric cautery or a paquelin (Fig. 4). We use heavy silk or narrow tape, as finer material is likely to cut through. The ligature on the upper stump is left long. The lower stump is inverted by a silk pursestring suture in a similar manner that one buries an appendix stump (Figs. 5 and 6). If there is

Fig. 10. Œsophagus stump has been united with the gastrostomy by means of a rubber œsophagus.

room a second pursestring is placed and the stump is completely inaginated into the stomach; otherwise one places a few interrupted sutures better to secure the first pursestring. Attention is now directed to the upper end. By means of a forceps passed from above behind the arch of the aorta, the long ligature which had been left on the upper stump is grasped and the œsophagus with the tumor drawn upward until it emerges above the arch (Fig. 7). It is then wrapped in moist gauze and by blunt dissection easily freed upward as far as the neck.

On completion of this part of the operation, the thorax is temporarily partly closed, towel clips being used for approximation of the skin edges, and the patient is turned on his back. During these manipulations it is difficult to maintain proper asepsis, and great care must be used. At this stage the value of having the left arm free and in the care of a sterile nurse becomes apparent. The left side of the neck is now exposed and may have to be prepared a second time. An incision about 3 inches long is made along the anterior margin of the left sternocleidomastoid muscle. The large vessels are retracted outward and usually without difficulty the œsophagus can be isolated (Fig. 8). This is of course easiest if the dissection from below has been carried high. In case difficulty is experienced it may be necessary again partly to turn the patient, and with a hand inserted from below, aid in the identification of the œsophagus. As soon as it has been completely freed it is drawn out of the neck wound, wrapped in moist gauze, and temporarily left there.

The patient is then again turned on his side and the chest re-opened. By means of a continuous plain catgut suture the pleural margins are united from the dome of the thorax to the arch of the aorta. This can usually be done without difficulty. The neck wound is thus shut off from the pleural cavity and entrance of air is avoided. A similar procedure is followed with the pleural edges below the arch. It is wise at all times to suture this portion of the pleura in order to cover the mediastinum, but it is especially valuable in patients in whom the opposite pleura has been opened, as by this means two pleural cavities are re-established.

In case drainage of the thorax is advisable, a stab wound is made posteriorly through one of the lower intercostal spaces and a half inch soft rubber tube is inserted for a distance of about 3 inches. It should have an end and a lateral opening and be fastened to the chest wall by means of a suture passed through a rubber cuff.

The lung should now be fully inflated and closure of the thoracic wound begun. A few heavy chromic catgut sutures are passed around the opposing seventh and eighth ribs and used for approximation. The ends of the divided ribs fall into apposition without difficulty. The parietal pleura usually can not be sutured separately and it is not necessary to attempt it. A running plain catgut suture will approximate the intercostal tissues and with them the pleura, but the wound will not be airtight until the various muscle layers of the thoracic wall are likewise united. Interrupted chromic catgut is best for this purpose. The skin is closed with interrupted silk, or in case haste is imperative, with a continuous plain catgut. During all this time it should be the aim of the anæsthetist to keep the lung inflated as it helps the general condition of the patient and prevents a pneumothorax. A dry dressing is applied, sealed with adhesive plaster, and the patient is turned on his back, and after making sure that the lung is fully expanded the drainage tube is clamped.

Attention is now directed to the neck wound and the projecting œsophagus. After retracting

the skin edges, the muscles are closed around the œsophagus without making any undue pressure. A subcutaneous tunnel is then made by blunt dissection from the lower end of the neck wound downward usually to the level of the second intercostal space and a transverse incision made at its lower end (Fig. 9). The œsophagus with the tumor is drawn through this tunnel and out of the lower incision where it is sutured to the skin margin with interrupted silk. The projecting portion containing the tumor is then removed with the cautery. The stump must be left open to permit the free discharge of saliva. The neck wound is closed with silk and a dry dressing applied.

AFTER-TREATMENT

After the patient is returned to bed, the drainage tube is inserted into a bottle on the floor with its end under a fluid level, which effectually establishes a closed method of drainage.

Measures to counteract shock are instituted as indicated. Hot water bottles are applied to the body, a hot coffee enema of 6 ounces is given containing one ounce of whiskey and grains 1/15 of strychnine. Cardiac stimulants have usually been given during the operation and are continued as the condition of the patient seems to require.

In case there has been much loss of blood, a transfusion is given. Morphine is administered in small quantity at regular intervals to relieve pain and to quiet respiration. It is of great value.

During the first 24 or 48 hours, water is given by hypodermoclysis under the skin of the thighs or by proctoclysis. After that it is given through the gastrostomy tube, at first by the drip method and later in gradually increased fixed quantities at regular intervals. In case it was not possible to get a good inversion of the œsophagus stump into the stomach, and leakage is feared at this point it is best to delay administration of fluids into the stomach a few days longer. Nourishing fluids may be added or substituted for the water as soon as the condition warrants it, about the same as in ordinary postoperative cases.

In addition to the removal of the carcinomatous lesion of the œsophagus, one of the aims of this operation is the re-establishment of the function of deglutition. As the greater portion of the œsophagus has been removed, a substitute has to be found, and a rubber tube has been used for this purpose very successfully. Unless there is disturbance of healing with the neck wound or around the œsophageal fistula, the patient may be encouraged to swallow saliva and fluids a few days after the operation. All fluids so swallowed naturally flow out of the fistula and have to be caught in a basin. Patient is then given food to masticate and swallow and when the function is well established a rubber œsophagus is inserted into the fistula and connected with the gastrostomy tube below (Fig. 10). The tube is armed with a rubber cuff about 2 inches from its upper end, which makes it fit snugly against the œsophageal opening after insertion. A pin is fastened in the cuff and by means of a tape passed through it and around the neck the tube is held in place. To avoid leakage during deglutition, the patient makes light pressure with his fingers over the œsophagus on either side of the tube. He masticates his food thoroughly, and then swallows it the normal way, the food passing through the pharynx, upper œsophagus, and then through the rubber œsophagus into the stomach. A little more fluid is required than for people with a normal œsophagus. Between meals the tube may be withdrawn from the œsophagus and closed with a cork, or it may be left in place, as the patient desires.

For comfort a bed which allows elevation of its upper end is desirable, as patients usually breathe better and feel more comfortable in that position. We use Gatch beds for these patients. As soon as the condition permits, patients should be encouraged to sit out of bed.

No special attention is required for the external wounds. If they remain clean and heal by primary union the sutures are removed on the seventh or tenth day. The sutures holding the œsophagus stump have to be left a little longer to prevent retraction. Physical signs, a bedside X-ray examination of the chest, a record of the pulse and temperature, and the amount of drainage through the tube, all will give an indication of the intrathoracic condition. If the lung remains well expanded, and the amount of drainage is slight, decreases daily, and is not badly infected, the drainage tube should be removed and discontinued. If a real infection develops, on the other hand, drainage has to be continued and the patient treated as a regular empyema case. In the weakened condition of these patients, such a complication would have to be considered a very serious one.

Complications resulting from disordered function of the heart and kidneys are best avoided or overcome by the treatment already outlined. One has to be constantly on the alert to support the patient in whatever way seems indicated.

From the description of this operation it will be apparent that it is of considerable magnitude

and that it would place a strain on even a normal person. The importance of early diagnosis is therefore evident and the point must be stressed that patients have to be referred for operation before their resistance has been lowered by undernourishment and carcinomatous cachexia, and the local lesion has progressed to a stage where it interferes with surrounding vital organs and makes operative removal impossible.

It is well known that there are many difficulties connected with the early diagnosis of this condition and that symptoms are frequently entirely overlooked until obstruction occurs. It should always be remembered that slight disturbances of deglutition may mean an early œsophageal carcinoma and therefore proper, thorough examination should be made at once. Only in this way can we hope to treat patients early enough to secure the maximum benefit and avoid waiting until, as at present, the great majority are found to be inoperable on first examination and only in an exceptional case can operation be done successfully. There is reason to believe that in properly selected cases this well standardized operation will obtain a larger precentage of recoveries than has been the case so far.

CONGENITAL CYSTIC DISEASE OF THE LUNG

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THE scant number of congenital cysts of the lung reported in the American literature justifies the addition of this series. I have been able to find but four American observations: two of R. T. Miller; a description of an anatomical specimen by Pappenheimer of New York; and one of my own. The German and French literature is fuller. The picture of this disease, so striking in both its clinical and pathological aspects, has received considerable attention from German authors.

Congenital cysts of the lung occur in two forms: one the solitary cyst, and the other cystic disease proper with a more or less diffuse cystic degeneration of larger or smaller parts of the lung. The two forms may co-exist, which was the condition present in my first case.

Solitary cysts may lie within the parenchyma of the lung; they may occupy the site of a whole lobe; they may sprout from other organs to which they are developmentally attached, e.g., the trachea or the œsophagus; they may even have been displaced by congenital malformation into an extrathoracic position, thus a cystically degenerated accessory pulmonary lobe has been found in the upper abdomen.

Clairmont reports a congenital cyst of the right middle lobe in a boy of 10 which had no communication with a bronchus. The cyst contained pus and was at first mistaken for an interlobar empyema. The temperature reached 39 degrees and the X-ray films might well be interpreted as depicting an interlobar effusion. At operation, however, the pus was found lying not next to the thoracic wall but centrally, so that it was necessary to traverse lung tissue in order to reach it. Later, after the lung had retracted, it was apparent that the cavity had an epithelial lining with what seemed to be a bronchus debouching into it. This circumstance established the diagnosis. Although very little air was expelled from the cavity, touching it provoked no cough and there was no expectoration either of blood or mucus. The boy died some 14 months later following an attempt at extirpation and closure. At autopsy the remains of the cyst were found in the right middle lobe; it was lined with cuboid bronchial epithelium. Sauerbruch, Sultan, Gold, Rach, and others report similar observations. One of my own follows:

CASE 1. Mr. P. S., a retired saloon-keeper of 60, who had had occasional attacks of cough and fever thought by him to be "grippe," consulted Dr. Arthur Sonnenberg for bleeding from the rectum. The patient had paid no attention to his cough and had never had sufficient trouble with his chest to see a doctor for it. Examining the chest as usual before beginning the gastro-intestinal roentgenography for which the patient was sent to him, Dr. Rehfisch was struck with an annular shadow at the bottom of the right chest and took films, reporting as follows:

"Fluoroscopically the diaphragm moves well and equally on both sides and the posterior mediastinum is clear. There is a delicate lineal shadow near the right base which marks off anteriorly a segment of lung which suggests a possible cystic middle lobe. On the contrary, however, this may be only a markedly fibrous interlobar septum. There is also a little fibrous trabeculation at the left base where the appearance suggests possible congenital cyst at the base of the left lower lobe. The upper two-thirds of the lung fields are clear, and the heart and aorta are within normal limits of size and shape."

A possible diagnosis was made of congenitally cystic lung.

The bleeding proved to be due to rectal polyps and was relieved by Dr. Sonnenberg's treatment. Knowing of my interest Dr. Sonnenberg kindly allowed me to examine his patient. The right chest of this pale, not very well preserved old man was distinctly although not greatly retracted and moved less than the left. There were basal crepitations on both sides but no changes in breath sounds and no difference in resonance. The apices were perfectly free.

On the 8th of May lipiodol was injected. Dr. Rehfisch reported: "Approximately 20 cubic centimeters of lipiodol were injected into the right base. The injected bronchi are very interesting in that they almost completely surround the thin walled cystic sac in the right lower lobe. Their relation to this cyst is beautifully brought out in the stereoscopic views. The small peripheral cyst at the costal diaphragmatic angle is also clearly made out, though unfortunately here too no oil entered the pathological focus."

Bronchoscopy was not done, nor was the patient treated for his cyst, he having no symptoms to warrant it.

There is no doubt of the congenital origin of these solitary cysts.

The second form, cystic disease proper, variously termed congenital bronchiectasis, "honeycomb lung," saccular degeneration of the lung, etc., is possibly more frequent than the solitary cyst. Meyer and later Grawitz described the pathological anatomy in some detail. In this form, a whole or a part of one lobe, or even a whole lung itself may show various degrees of cystic degeneration, ranging from multiple miliary cysts scattered through a normal parenchyma to conversion of a lobe or of a whole lung into a huge multilocular or unilocular cystic sac (Case 2).

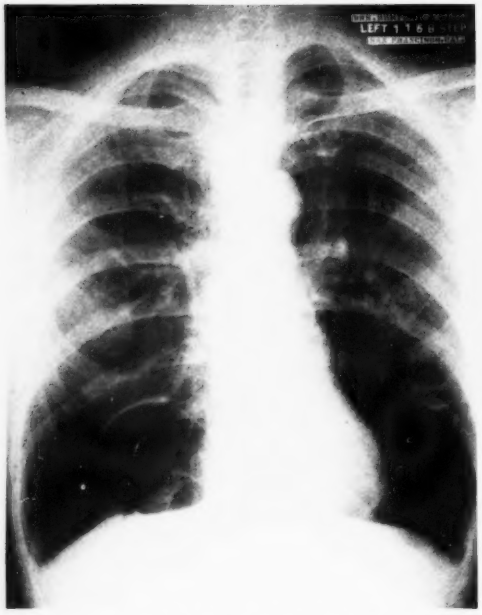

Fig. 1. Case 1. Anteroposterior view of large cyst at right base.

Fig. 2. Case 1. Lateral view of large cyst at right base.

Mild degrees of cystic degeneration accompanied usually by more or less atelectasis have been repeatedly described by pathological anatomists and are depicted in many textbooks. In their early stages, at least, they elude clinical recognition. More pronounced cystic changes with saccular or clubbed dilatation of the bronchial endings are subjects of controversy. Some authors follow Grawitz in considering most of them congenital, others consider them acquired.

They may be present at birth or in the first few months of life. Heller, Orth, and others think that they are due to a persisting fetal atelectasis in which the expanding thoracic cage, finding no yielding alveolar tissue upon which to exert its expansile force, expands the bronchi instead.

Sauerbruch, Kissling, and Borst consider congenital cystic disease much more frequent than is ordinarily assumed. Heubner, the Nestor of German pediatricians, Wiese, and most German pathologists consider that bronchiectasis is rarely congenital. The problem is difficult, for the history of acute respiratory infection, such as pneumonia following measles, which is often adduced as the cause of a saccular dilatation of the bronchi, speaks neither for nor against the question of congenital versus acquired origin. Respiratory infection may not be a cause but merely the factor which, changing an aseptic and symptomless cystic lung into an infected and suppurating one, makes disease manifest. Cysts themselves may cause no symptoms. So long as they are uninfected their carrier may be unaware of their presence. It is suppuration that makes the disease. Sauerbruch remarks in this connection "what we are accustomed to look upon as the cause of bronchiectasis, chronic recurrent catarrh, is already the expression of suppuration in the cavities."

While it may not be possible to establish a congenital or acquired origin in every given case, pathological anatomy has brought out facts that make the congenital origin of some dilatations at least certain. Thus cystic dilatation of the bronchi has been found in the newborn and in the fetus. Grawitz distinguishes two congenital cystic anomalies, a universal bronchiectasis in which a main bronchus and all its side branches are dilated so that the main one forms a large cyst with many small cysts debouching into it, and a telangectatic bronchiectasis in which the smaller bronchioles are cystically dilated, the dilatations sometimes

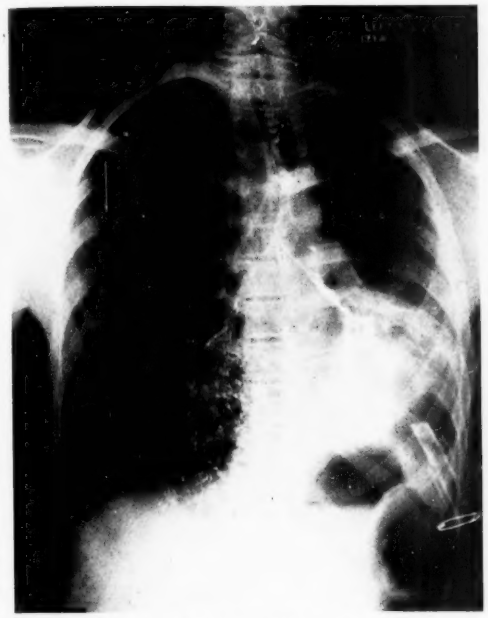

Fig. 3. Case 2. Before operation. A large unilocular cyst occupies the left upper lobe; multiple cystic pouches filled with lipiodol occupy the left lower lobe. The heart and mediastinum are much displaced to the left and the left side of the chest is much retracted.

being open, sometimes closed, sometimes strung one after the other on the thread of an occluded bronchus, like beads on a rosary.

In these two forms of multilocular cystic disease Sauerbruch and Lotzin have found that congenital bronchiectasis frequently presents an irregular conglomeration of cysts, some without connection with the bronchial tree, that these cysts are lined with a single layer of ciliated epithelium, and that the wall is usually free of ulceration or inflammatory deposits. In the congenital form the cystic areas are free of carbon and inhaled pigments; in the acquired form pigment is not wanting and the bronchi are inflamed and ulcerated.

The congenital origin of the most marked degrees of sacculation admits of no doubt.

Case 2. A young student of 20 years was referred to me by Dr. James W. Ward in 1927. There was no lung trouble in the family. The boy had had all the ordinary diseases of childhood: measles, whooping-cough, scarlet fever, and frequent sore throats. Before his present illness he had his tonsils removed; since then he has had no further trouble with his throat. As a child he had a lymphadenitis and lymphangitis of the arm following an injury which laid

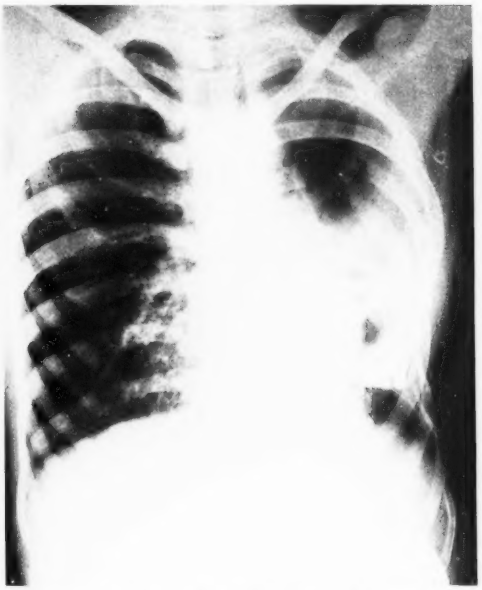

Fig. 4. Case 2. After operation. The large cystic pouches are filled with lipiodol introduced through wound.

him up for 7 weeks. He recovered from all of these infectious ailments with no difficulty; none of them affected his chest.

In 1917, at the age of 9 years, he had what was thought to be a pneumonia that lasted 6 weeks; with it he had a constant cough, but no expectoration. The pneumonia was thought to have been followed by an empyema. Since this illness he has had an attack of fever about every 6 months. His chest was aspirated periodically and finally was opened by Dr. Ward in 1920, much pus being evacuated.

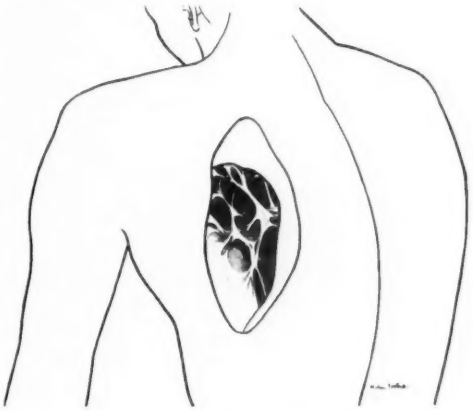

Fig. 5. Case 2. Cysts of lower lobe opened.

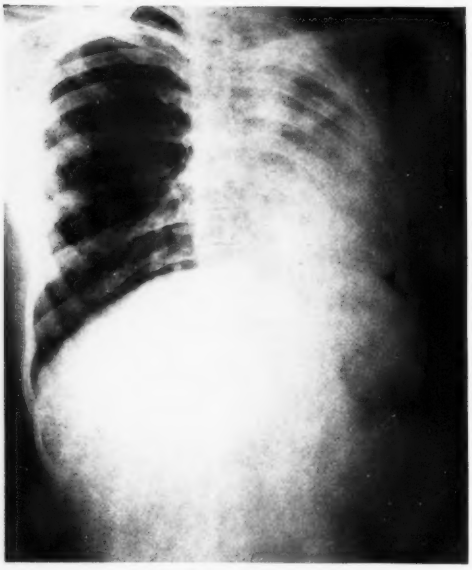

Fig. 6. Case 3. Much retracted, uniformly gray left chest.

The chest has remained open ever since; he wears a drainage-tube in it. Bismuth paste was injected into the opening a number of years ago; he promptly coughed out the paste.

He is very thin and dyspnœic on exertion, but he feels fairly well except for his chest. I first saw him for a short visit on September 12, 1927. He was a lad of about 6 feet 2 inches in height; he weighed about 110 pounds. The pulse was 60, the blood pressure 120–80; there was no rise in temperature.

The cervical and axillary glands were moderately enlarged and soft. The skin was of the pale greenish hue of chronic sepsis. The thyroid was about one and one-half times normal size, soft and of uniform consistency.

The chest was flat; the left side was retracted and stood still. It was tympanitic upon percussion. There were no breath sounds to be heard over it. There was a drainage tube inserted into a small opening in the tenth rib, at the line of the scapular angle. There was very little secretion from the tube. Air escaped from the drainage opening when he breathed or coughed and a few drops of ether injected into it immediately provoked a cough. The right side of the chest was free; there were no râles at either apex.

The heart was displaced 1 inch to the left of the left nipple line; the right border lay ½ inch to the left of the sternum. The liver and spleen were not enlarged and not palpable; the rest of the abdomen was normal. There was no œdema. The urine was normal. The blood-count was as follows: hæmoglobin, 85 per cent (Sahli); red blood cells 5,080,000; white blood cells 7,800; polymorphonuclears 68 per cent; lymphocytes 32 per cent.

Dr. John Rehfisch reported that the X-ray examination showed the following: Chest (October 11, 1927)—fluoroscopically, the left diaphragm cannot be distinctly made out though its dome is more or less well outlined by a gastric air-bubble below. It does not move. The right diaphragm is hyperactive. Stereoscopic anteroposterior chest films show a very marked collapse of the left lung with a large pneumothorax occupying practically the entire upper half of the left chest. The lower lobe would seem to be not so well collapsed. It is densely atelectatic and the bronchial tree supplying it, which is air-containing, can be well made out below the heart shadow; this is especially well demonstrated when the plates are viewed stereoscopically. A portion of the tenth rib has been removed posteriorly and a drainage-tube is inserted through this bony defect into the lower portion of the left chest just above the diaphragm. There is no fluid present. The heart and mediastinal contents have been displaced toward the left and much of the hilus shadow of the right lung lies behind the vertebral column. The right lung itself appears normal so far as active pathology is concerned. There is a small calcified nodule at the right top. The roentgenographic conclusion was: Drainage-tube in left chest with complete collapse of upper lobe and partial collapse of lower left lobe.

Lipiodol injection of chest (October 12, 1927)—Fluroscopically the lipiodol is seen to be partially obstructed just below the point where the left major bronchus takes origin. A considerable amount of oil drips slowly down past this point and enters a small bilocular puddle with its lower margin at the summit of the dome of the diaphragm. This puddle has a clearly demonstrable connection with two large bronchi and its bronchial relations are beautifully demonstrated in the stereoscopic films.

The lateral view shows that this bronchiectatic puddle is very near the dorsal border of the left base. When the patient raises his intrathoracic pressure voluntarily, the oil is forced upward and out of the drainage-tube.

From this examination it was concluded that there was a stenosis of the left lower bronchus with peripheral bronchiectatic dilatation in the partially collapsed lower left lobe with a bronchial fistula connecting it to the outside.

I diagnosed a chronic empyema with a bronchial fistula, and thought it most likely that we had to deal with a congenital bronchiectasis that had perforated into the chest. I advised an attempt at closure after the manner of Colonel Keller.

I may as well state here that both Dr. Rehfisch and I were mistaken. What we took to be a large pneumothorax cavity was not a pneumothorax, but a huge unilocular cyst of the left upper lobe. The left lower lobe was not collapsed, but consisted of a series of bronchiectatic cysts, and the drainage tubes lay in one of these cysts and not in the pleural cavity.

On October 20, 1927, under satisfactory gas and local anæsthesia, a curved incision was made over the left chest and about 5 or 6 inches of three ribs, including two below the one which had grown around the drainage tube, and this rib itself, were resected. Upon opening the pleura one entered a sacculated multilocular cavity into the top of which an open bronchial mouth debouched. The upper part of the chest, which from the radiographs seemed to consist of one large pneumothorax cavity, was now seen to be closed from the present thoracic opening by the above mentioned sacculated membrane. The pericardium lay at the front of the wound. The soft parts were brought down over the pericardium with one mattress stitch, and the rest of the wound was left open, the sacculated cavity being packed with balsam of Peru gauze. It appeared probable that the cavities were bronchiectatic.

The boy made a good recovery.

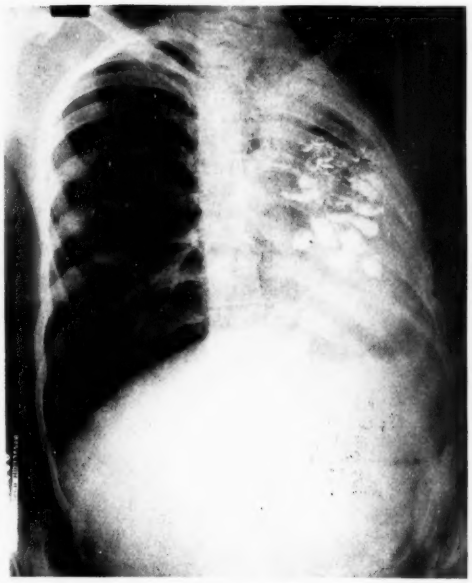

Fig. 7. Case 3. Left chest injected with lipiodol which has puddled in the cystic cavities. The mediastinum, the trachea, and the heart are much retracted to the left; the left diaphragm is high.

Fig. 8. Case 3. Lateral projection of cystic cavities filled with lipiodol.

On November 7, 1927 my notes read: "The old cavity, exposed at previous operation, is clean and granulating. The pericardium is visible in the bottom of it, and between it and the chest wall lies a trabeculated meshwork into the pouches of which various bronchi debouch; touching these bronchi immediately provokes a cough. Access to the upper part of the pleural cavity which radiographically seems to consist of a single large space is not got by this first operation; a needle introduced into the upper chest in two places withdraws air. In order to open the upper part of the chest, therefore, 2½ inches of two more ribs are resected from about the costal angle forward. The underlying parietal pleura is about ⅛ inch thick; underlying it and clearly separable from it in a cleavage plane is another thin membrane, perhaps 1/32 inch thick; when this is entered one looks into a large cavity, occupying the whole upper chest, gray and glistening, its medial surface pierced by numerous openings, the largest perhaps ⅛ inch across, some of them running as tunnels superficially in and out of the thin membrane, others probably running toward the bronchi. Between this very large cavity and the multiple trabecular ones, opened at the previous operation, lies a thin, but tough, fibrous septum perhaps a little over ¼ inch thick, which in its center clearly carries a little spongy lung tissue. This septum runs on to the chest wall and completely separates the newly opened very large upper cavity from the small trabecular ones opened at the first operation. Diagnosis: congenital maldevelopment, left lung. Bronchiectasis of lower left lobe, and enormous bronchiectasis of left upper."

After about a week the drainage tube was removed from the large cyst of the upper lobe; the opening closed and no further fluid collected in it. The trabecula of the lower lobe shrank in the course of the patient's 2 months' stay in hospital, leaving exposed the large, shallow, half-opened pouches that represented the open cysts of the left lower lobe. They were lined with a velvety, red, bronchial mucosa. Touching them provoked no cough, but the large lumina leading toward the hilum were extremely sensitive, so that touching them with an instrument sent the patient into fits of coughing. The pouches secreted a clear, thick, viscid mucus.

On January 24, 1928, the sacculated and open lower lobe was dissected off from the pericardium and diaphragm to which it was attached, partly with a knife, partly with the galvanocautery. A thin layer of alveolar parenchyma surrounded the large pouches. At the end of dissection two large bronchial branches led into the left lower main bronchus. These were cut across, the vessels of the hilum were tied, and the bronchial mouths closed with fine black silk sutures. The soft parts, the skin, and the subcutis were loosened, dropped in over the bronchial stump, and loosely united with silkworm-gut sutures. A transfusion was done on February 7.

The boy again made a good recovery and on March 12 was sent home with a small sinus leading to the stump of the left lower main bronchus which still secreted a few cubic centimeters of mucopus a day. Since he has been at home a few black silk sutures have been discharged from the sinus. A lipiodol injection shows it to lead into the left main bronchus. No connection between the large cyst of the left upper lobe and the sinus is demonstrable.

The boy has been at school for two and a half years. A minute bronchial fistula, discharging a few drops daily still persists. The upper cavity has given no trouble and remains empty. The lad although free of fever and sepsis is still much underweight.

Although the single sacs were smaller, sacculation was equally extensive in the following case:

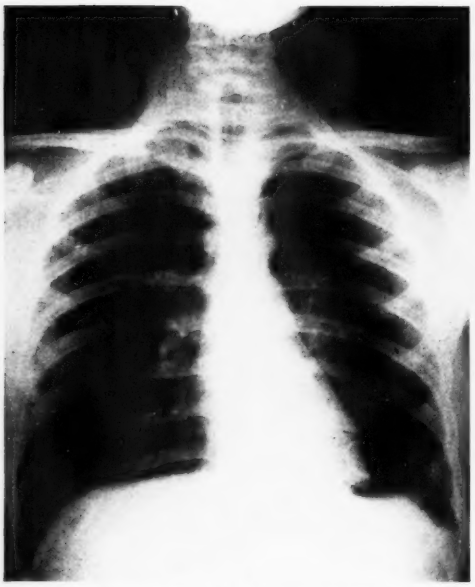

Fig. 9. Case 4. Collection of annular shadows (cysts) at base of left lower lobe.

Fig. 10. Case 4. A lateral view of the cystic cavities some of which lie behind the heart and are apparently filled with fluid.

CASE 3. Pasquale M., an Italian boxmaker, 20 years of age, entered the Tuberculosis Department of the San Francisco Hospital in Dr. W. R. P. Clark's service on April 15, 1929. He complained of a dry cough of 1 week's duration which troubled him most at night. Four days before entry he had brought up perhaps a tablespoonful of bright blood. Except for this recent complaint he had considered himself perfectly well and healthy.

He was a thin young man in no distress. The chest was thin, poorly clothed; its movements were restricted on the left side. The heart was markedly displaced to the left. The apex of the left lung was dull and the fremitus was increased here, but diminished at the left base. Over the whole left side the breath sounds were diminished, and there were many râles. The right side was free. Bronchoscopy by Dr. Tillotson[1] revealed a narrowing of the left main bronchus beyond which the instrument could not be passed. "The carina, instead of occupying the normal anteroposterior position (vertical in appearance, as viewed through bronchoscope with patient lying on back), occupied an oblique position. The relative diameter of the upper or left main bronchial orifice was much smaller than that of the right and presented in its upper portion a slightly granular appearance, not reddened or bleeding on touching as would suggest true granulation tissue. The orifice of the left main bronchus was too small to admit the tip of the 7 millimeter bronchoscope. No free secretion was noted coming from this orifice. On passing the bronchoscope along the right main bronchus a small, apparently anomalous, bronchial orifice was noted in its left lateral wall at less than 1 centimeter from the carina. On subsequent lipiodol injection this appeared from the X-ray film to communicate with the left main bronchus. The upper lobe bronchial orifice on the right and the orifices of the middle and lower lobe bronchi on the right were identified and appeared normal. No free secretion was encountered in the right main bronchus. No granulations or ulcerations of the mucosa were noted. A No. 12 rubber catheter was introduced through the bronchoscope to the left main bronchus after which the bronchoscope was withdrawn and the catheter left *in situ*. The patient was moved to the fluoroscopic room and lipiodol was introduced through the catheter with a Luer syringe, the distribution of the oil being observed under the fluoroscope. X-ray plates taken in the anteroposterior and lateral planes are shown in Figures 7 and 8."

The following report on the X-ray plates was given by Dr. Rehfisch:

"There is a very satisfactory lipiodol injection of the posterior portion of the collapsed left lung. The lipiodol is gathered in small puddle-like masses demonstrating the presence of a grapelike cluster of bronchial dilatations. In view of the total absence of clinical evidence pointing toward true bronchiectasis, the possibility of a cystic dilation of the bronchi must be strongly considered."

On June 8, 1929, bronchoscopy was repeated. The appearance of the tracheobronchial tree, open to inspection through the bronchoscope, was the same as at examination May 21, 1929, with the exception of the fact that the granular contour of the upper portion of the left main bronchial orifice was not noted in this examination.

The patient was free of fever while in the hospital. No tubercle bacilli were found in the sputum. The Wassermann reaction was negative.

Multilocular cystic disease involving but a portion of the left lower lobe was found in the following patient:

[1]Reported by Dr. R. S. Tillotson, California & West. Med., 1929, xxxi, No. 6.

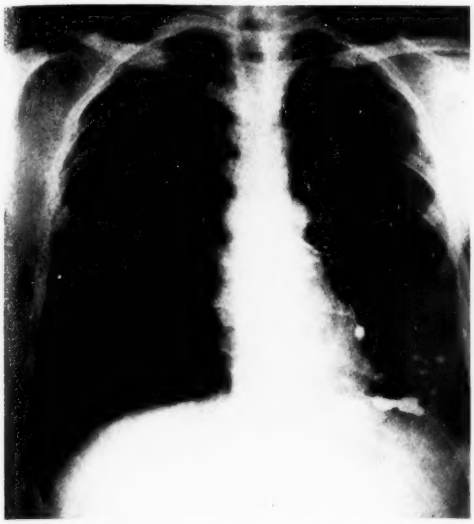

Fig. 11. Case 4. A little lipiodol has been injected into the cysts. It puddles at their bottom.

Fig. 12. Case 4. Lateral view after lipiodol injection.

CASE 4. Francis B., a robust young man of 23 years, was referred by Dr. S. with a request for an opinion. The young man had asked for Dr. S's. daughter in marriage but Dr. S. upon inquiry found that Mr. B. had a cough. He considered himself perfectly well and fit; had worked hard as a rancher and had spent some time at Stanford University where he trained on the football squad. He related that at the age of 12 years while putting his shoulder to the wheel of a mired wagon he suddenly began to cough and after this was laid up for 3 weeks with cough and sputum. He does not remember whether he had fever. He knows of no reason for his illness. There is no history of aspiration of a foreign body, of pneumonia, or other assignable cause. He was brought to Oakland under the care of Dr. von Adelung who tapped the chest at various points and finding pus drained it. The tube was removed after a few weeks, and the boy returned to his ranch in Lake County. The cough stopped, but returned some 3 years later. Since then he has coughed more or less and can always produce sputum, as he says, by standing on his head. For a time he could not lie on the right side, but he is now able to do so.

The patient was a robust, healthy looking boy of 22 years. The forehead projected unusually far above the nose, and on blowing his nose he produced some dry scabs. The tonsils were not inflamed, the teeth were good, the cervical lymph nodes were about the size of beans. The axillary glands were not enlarged.

The left shoulder was higher than the right, but the respiratory movements of both sides were almost equal, if not entirely so. There was the scar of the above-named drainage operation in the left lower chest, between the posterior and anterior axillary lines, with coarse râles here.

Put on the table and made to lean forward with his head over the edge and his body down, the patient immediately brought up nearly half an ounce of foul, almost entirely purulent sputum which contained some small inspissated chunks. The chest is otherwise negative, in particular, the apices are free.

The abdominal organs gave no evidence of abnormality.

I advised that pictures be taken of the chest and sinuses. I considered it likely that this boy was still harboring the remains of an empyema on his left side.

X-ray report: The heart vessel shadow is normal in size and position. The hilar markings are heavy and the pulmonary tree markings radiating into the left lower lobe appear as curious, whorled streaks. These are strongly suggestive of large, thick walled cysts or cavitations. In a lateral view a somewhat horizontal line of density is noted at the left base posteriorly.

Examination of the sinuses showed a very light degree of grayness in both maxillaries and frontals (the latter being rudimentary). This is indicative of slight, chronic mucous membrane thickening. The anterior ethmoidal cells appeared a little gray. The peculiar, cyst-like cavitation throughout the left lower lobe, without evidence of pneumonitis or infiltration, led to the conclusion that the patient was probably suffering from chronic, basal, pleural thickening with possibly a little fluid.

On October 26, 1929, an X-ray picture was taken of the chest after injection of lipiodol. The main bronchi entering the left lower lobe appeared normal. Two large cavities were seen with a little lipiodol in their inferior portions. Five small sacculi were also seen.

After consultation with Dr. Eloesser, it seemed strongly probable that there was a congenital, cystic condition of the left lower lobe, there being at least three large cyst-like areas with several small ones.

The sputum contained masses of pus cells and varied organisms, with morphology and staining characteristics of bacillus pfeifferi and micrococcus catarrhalis, as well as a few chains of streptococci, but no tubercle bacilli.

I considered operation not warranted in view of the mildness of symptoms.

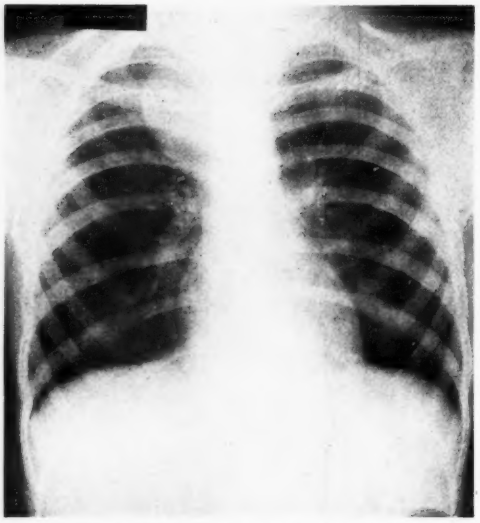

Fig. 13. Case 5. Lymphangioma of mediastinum.

The foregoing observations represent the various kinds of cystic disease—the solitary cyst and multiple cystic degeneration of various degrees and extent.

Missing from my series are observations of cystic disease in infants such as Miller reported. The infantile disease is characterized by sudden attacks of intense dyspnœa and cyanosis. Some of these attacks may possibly be caused by a spontaneous pneumothorax (although one is inclined to inquire what makes these lungs rupture), but most of them are caused by a sudden inflation of the cystic lung. Spontaneous pneumothorax has been observed at autopsy (Wiese), but how air entered the pleural cavity of the stillborn infant upon whom autopsy was performed does not appear. Miller's films and other observations denote rather a sudden hyperinflation of a cystic lung with displacement of the mediastinum than a pneumothorax. The thin walled cysts usually have a narrow bronchial outlet; crying or struggling entraps air in them as forced breathing entraps air distal to any partial bronchial stenosis, greatly raising intrapulmonary pressure, deflecting the thin mediastinum, and compressing the sound lung. It is this sudden compression of the sound lung by the dilated cystic one that causes the sudden attacks of dyspnœa and cyanosis characteristic of the disease in infants.

A case of lymphangioma simulating in some particulars cystic disease I owe to the kindness of Dr. George D. Lyman, who will report it in full.

The boy when seen on June 5, 1928, was 8 years old. When he was an infant of a few months he was examined by Dr. Lyman who noticed a swelling in the clavicular region, he thinks the left, which came and went, so that he thought of a herniation of the lung. The child was X-rayed by Drs. Ruggles and Bryan who reported a lung hernia coming through the first intercostal space. At the same time there was seen on the left side of the mediastinum a round globular mass. The child was subjected to X-ray treatment; the swelling above the clavicle disappeared and no further symptoms of intrathoracic trouble made themselves apparent. Therefore, no further X-ray pictures were taken and the child apparently developed in a perfectly normal manner. His tonsils were removed several years ago under general anæsthesia without ill effects. His father, however, thinks that he noticed, when the child laughed or cried, that a swelling appeared above the right clavicle about the size of a fingertip.

About a month ago the boy had an attack of mumps and Dr. Lyman, who examined the neck at this time on account of the large swelling of the parotid, was quite sure that no noticeable mass was present in it. About 10 days ago, after the boy had been in swimming, a lump made itself apparent above the right clavicle: this lump has increased so rapidly in size, that there is considerable variation from day to day.

The boy has had bronchitic attacks not infrequently with some cough and perhaps a little wheezing on exercise; the latter, however, is not certain. Otherwise he is perfectly well and healthy.

The boy is well developed. Above the right clavicle there is a soft, movable mass twice the size of a hen's egg, which swells up to perhaps one-eighth of its size larger when the child coughs. It is encapsulated and cannot now be dislocated at all below the clavicle, although Dr. Lyman states that on first feeling it, and when it was smaller, part of it could be caused to disappear into the chest by pressure. The mass is not at all tender; the skin above it is not changed. The right jugular is a little more prominent than the left and the veins of the skin are slightly more prominent on the right. There is no cyanosis of the arms and no stridor. Distinct from the swelling there is another one, biscuit-shaped, lying under the right trapezius muscle, from which it may be dislocated forward. This one is also soft and encapsulated and about 1¼ inches in diameter. There is no dullness over the chest and no change in the respiratory excursion. There are diffuse squeaks and wheezes scattered all over the left chest and a few also at the right base. There are no glandular enlargements. The liver and spleen are not enlarged. The abdomen is negative.

Dr. Harold Brunn operated on the child. Dr. Rusk reported the specimen to be a lymphangioma (Fig. 13).

Recognition of cystic disease is not impossible in forms sufficiently severe to produce symptoms—in the milder ones recognition is unimportant. In the infantile form unexplained recurring severe attacks of cyanosis and dyspnœa with signs simulating pneumothorax, displacement of the mediastinum, hyperresonance, and absent breath sounds, will arouse suspicions which the X-ray may confirm. A shadow across the air-filled chest corresponding to an interlobar fissure will permit of differentiation of a dilated cyst of lung from pneumothorax; injection of the cyst through the chest wall with lipiodol may show

Fig. 14. Case 6. A large encapsulated tubercular empyema of 5 years' standing simulating a cyst.

Fig. 15. Case 6. Lateral view.

the cystic structure still more clearly and is perfectly justifiable, for the pressure dyspnœa can only be relieved by puncture or thoracotomy.

Cystic disease in the adult may remain silent as long as the cysts are sterile and filled with mucus or air (Case 1). When infection supervenes they present the picture of a widespread bronchiectasis with cough, copious purulent sputum, dyspnœa, fever, sweats, and other constitutional symptoms. The chest wall of the affected side is retracted. The retraction probably takes place in early childhood; in infants the affected side may be distended. Accordingly as the cavities contain fluid or air, percussion may give a dull or a resonant note; in the adult the pleura is usually thick enough to mask any resonance the underlying cavities may produce. Breath sounds may be absent or tubular and there may be the tinkle of a large cavity such as one is accustomed to associate with pneumothorax.

Bronchoscopy may reveal anomalies of the bronchial tree.

The X-ray may show a single large annular shadow if the cyst is empty, or a more or less globular area of density if it is full of fluid. The density of a single cyst, especially if more or less pneumonic infiltration accompanies it, may be not round but quadrilateral or wedge shaped. Wedge shaped shadows are indistinguishable from interlobar collections of fluid; the rectangular ones may arouse suspicion that they are due to another cause. When the cysts are empty, multiple cystic disease is documented by a network of honeycomb or grape-cluster-like shadows occupying part or whole of a lobe (Case 4) or even a whole lung (Case 3). When they contain fluid or are infected separate cysts are usually indistinguishable in the uniform grayness of a surrounding acute or chronic pneumonic reaction. If the cysts communicate with a bronchus lipiodol injection demonstrates them beautifully, large or small areas of the lung field being sprinkled with half-moon shaped fluid levels that look like the images cast on the ground by an eclipse of the sun (Case 3). Larger dependent cysts may be entirely filled (Case 2). Cysts without a bronchial opening may be outlined in negative by the iodized oil which pours into the open bronchi surrounding them but leaves the cyst itself blank. These films give good stereoscopic pictures but do not adapt themselves to reproduction.

Differential diagnosis. The solitary congenital cysts are most frequently confounded with other cystic collections, such as echinococcus (Sauerbruch), interlobar empyema (Clairmont), or with dermoids and similar solitary tumors.

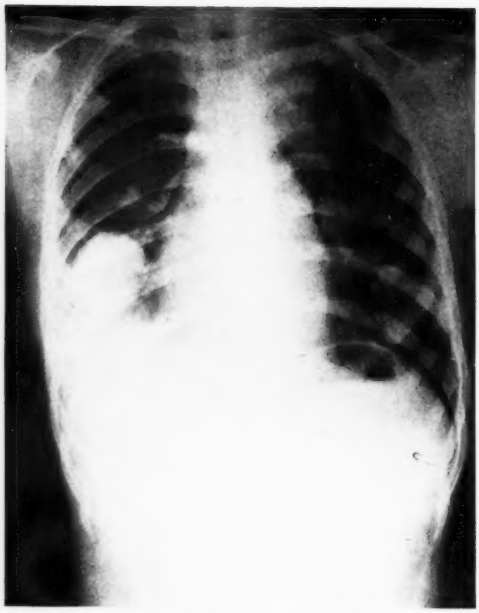

Fig. 16. Case 7. Encapsulated tubercular effusion simulating a cyst.

A large robust iron-worker who was under the care of most competent observers for 5 years (among them the late Dr. A. W. Hewlett) offers an interesting instance of the difficulties of diagnosis. In 1922 he was at Stanford Hospital with a cystic collection of fluid (Figs. 14 and 15). He had no fever, cough, nor sputum. Aspiration yielded a syrupy fluid containing staphylococci. He was discharged without a definite diagnosis having been made. In 1926 after various sessions at other hospitals he entered St. Luke's. The cyst was opened and drained of a chocolate colored content, its wall was beset by chalky coral-like plaques of stony hardness. Examination of the fluid and sections of the wall by Dr. Ophuls revealed layers of fibrous tissue without scolices or other characteristic constituents. After operation, the man's temperature continued to rise without apparent reason, the cyst cavity being well drained and clean. Films revealed a small interlobar effusion of the sound side which was tapped of a milky serous fluid. Guinea-pig injection finally established the diagnosis of tuberculosis.

Films (Fig. 16) of a girl of 16 also depict a chronic encapsulated tubercular pleurisy or tubercular abscess.

The difficulties of diagnosis of a single cyst, therefore, may be great. Time, continued observation, constitutional signs of disease (urticaria in echinococcus and echinococcus or syphilitic complement fixation reaction) pulmonary tuberculosis elsewhere, aspiration and examination of the contents of the cyst and especially the findings at operation will usually solve the problem. Operative findings are most important, for the epithelial lining of a cyst, visible both to the naked eye and microscopically, is quite different to the fibrous lining of an empyema or other pleural cavity, and is perfectly characteristic. Suspicious also is a consistently mucoid or mucopurulent secretion. The pus from an empyema may be thick and slimy at first but as drainage continues it becomes more and more frankly purulent (unless dissolved by Dakin's solution); the pus of an infected cyst is mucoid at first and continues so as long as the cyst secretes. Minute multiple cysts are of no importance and are unrecognizable.

Multiple cysts of medium size are more easily recognized. Whether to consider them congenital or acquired, and the expression of true congenital cystic disease, or of a severe acquired bronchiectasis, is an academic question that lobectomy or autopsy even is not able to settle conclusively.

Three patients each with a whole lung converted into a series of pus containing sacs; the one apparently congenital; the second syphiltic; the third following an operation for hydrocele, presented exactly similar findings both at operation and in the X-ray examination. It is impossible to say whether the syphilitic and the postoperative ones had latent cystic disease made manifest by the implantation of an infection, or whether the apparently congenital one was not like the others, acquired and the result of a sinusitis or some other hidden infectious process.

A Nova Scotian nurse of 28 years was kindly referred by Dr. James R. Bullitt, of San Jose. She had been prone to coughs and colds since a little girl, and had had much trouble with her nose. As a child her colds used to appear only in the winter, lately fever and chills occurred every few months and lasted a week or two. Her temperature rose to 102 degrees and she was very sick. She brought up large amounts of purulent non-offensive sputum.

She had had nasal polyps, and in the midst of one of her attacks a right otitis media which ruptured through the ear-drum. The ear had discharged since.

Films after lipiodol injection demonstrated bilateral basal cavities. At autopsy both lower lobes were found converted into a conglomeration of grape-cluster-like saccular cavities; in the right middle lobe the cavities were more cylindrical (Fig. 18). Microscopically the cavities were inflamed and ulcerated. There was a heavy submucous inflammatory deposit and the epithelium was largely ulcerated. The cavities all seemed to connect with the bronchial tree. There were numerous although rather small patches of anthracotic pigment.

The pigmentation, ulceration, and the various forms of bronchiectatic dilation, with round cavities in the lower and cylindrical ones in the middle lobe, made it likely that this patient's disease was acquired rather than congenital.

Large multiple cysts converting the whole lung and whole lobes into a unilocular or multilocular pus containing sac have been most frequently

mistaken for empyema (Sauerbruch 2 cases, Case 3). The mistake is easy; the wall of the cyst is thin, fibrous, and contains no visible pulmonary parenchyma. It is impossible to distinguish it from a thickened pleura unless one inspects it at operation, when its pearly lustre, its division into multilocular cavities, and the appearance in it of bronchial openings which show either as narrow slits or fine circular openings will reveal its true character as an epithelialized cystic cavity. After they have been opened for some time the cysts assume the aspect termed by Lebsche "gridiron lung"; the epithelium becomes pink and velvety; the partitions stand out; the cavities retract and the bronchial openings often appear more clearly. Communication with the bronchi may be more or less free; more or less air may be expelled from the wound; and more or less of the fluid contents of the cyst be expelled into the bronchi.

The possibility should be borne in mind that any unusually obstinate large empyema cavity which after operation shows no tendency to contract, may be not an empyema but a congenital cystic lung.

Treatment is indicated only when the cystic anomaly causes symptoms. These will occasionally be due to pressure of a solitary cyst on the bronchi or on the great vessels (Rach), when an attempt at removal is in order. Pressure symptoms may also arise from hyperinflation or distention of an infantile cystic lung which should be relieved after the manner of Miller by introduction of a one-way valve tube.

Extirpation may offer considerable difficulty. It has been remarked that solitary cysts may have a pedicle attached to the trachea or œsophagus. Access may be gained via an anterior mediastinal route or through the pleura, either in two stages, after production of pleural adhesions if the cyst is infected, or directly if it is presumably sterile, or through the lung itself. An infected cyst had best first be drained through a sufficiently large opening, the lung having previously been made to adhere by an extrapleural tampon, and attempt at removal be left for later, should a fistula persist.

Large multilocular cysts, if infected, should be widely opened and drained; when they are clean the shell of the lobe containing them is dissected free of its surroundings until it depends from a pedicle. Dissection from the chest wall and from the pericardium is fairly easy; dissection from the diaphragm and along the interlobar fissure usually difficult, the diaphragmatic and interlobar adhesions being tougher and denser than those to the chest wall and pericardium. When a pedicle representing the connection of the cystic lobe with the bronchus and the large pulmonary vessels is reached, the vessels and bronchus are separated, the vessels accurately caught and tied, the bronchus severed and sutured with interrupted stitches of fine black silk, and the stump covered with the remnants of the cystic lobe which are held in place with fine catgut. The scar of previous operation is excised from the skin and the soft parts closed except for a small drain. Phrenicotomy will help obliterate the large cavity left by removal of the lobe; often enough ribs will have been removed at previous sessions to make further thoracoplasty unnecessary. The remaining lobe dilates, the chest wall sinks in and the large defect closes surprisingly quickly.

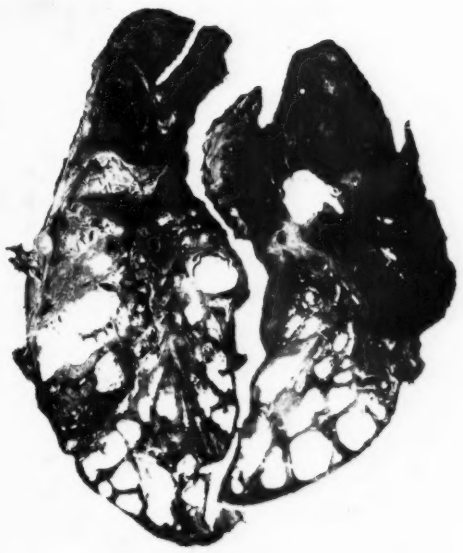

Fig. 17. Case 8. Probably an acquired cystic bilateral bronchiectasis of right middle and both lower lobes (the cavities have been injected with a barium gelatin mixture).

In Case 2, and in 2 other cases in which there was reason to suspect involvement of a whole lung, removal of the lower lobe seemed sufficient. The cysts of the upper lobe drained by their own gravity and produced little or no symptoms, after removal of the infected lower lobe. In one patient the sputum has dropped to 4 cubic centimeters per day; the patient is well and working. In another it measures about 15 cubic centimeters; the patient is well, has gained much weight, and is no longer disabled.

Whether or not one wishes to treat infected cystic lungs by thoracoplasty will depend on the taste of the operator. Certainly before doing so, one should make sure by means of the bronchoscope that communication between the cysts and the bronchi is free; to compress the infected cysts unless their secretions have a free vent toward the bronchi would be to invite disaster. Personally the results of drainage with subsequent lobectomy and closure of the bronchial fistula have been sufficiently encouraging to incline me against the uncertainty of less direct methods of attack.

SUMMARY

1. Four cases of congenital cystic lung are described.

2. Solitary congenital cysts are often mistaken for interlobar empyemas.

3. Encapsulated tubercular pleurisy may be difficult to distinguish from solitary cysts.

4. Infantile cystic disease often causes death from dyspnœa due to inflation of the diseased lung and compression of the sound one. This emergency can be relieved by the introduction of a valve tube.

5. Large infected multiple cysts are often mistaken for empyema, both before and after drainage. Unusual persistence of empyema and a mucous discharge should arouse suspicion of cystic disease.

6. Methods of treatment—extirpation, drainage, lobectomy, closure of bronchial fistula—are described.

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EPITHELIZATION OF BONE CAVITIES AND CALCIFICATION OF FIBROUS MARROW IN CHRONIC PYOGENIC OSTEOMYELITIS

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THREE cases of chronic pyogenic osteomyelitis of over 50 years' duration, presenting large bony cavities and draining sinuses, were recently observed. Study of the specimens obtained showed partial epithelization of the bony cavities. This was the result of proliferation of the cutaneous epithelium along the sinuses. Sequestra with calcified marrow and calcification of marrow in living bone was also noted.

The epithelization of the cavities obviously was a determining factor in the clinical course of these cases, for a cavity with a narrow outlet lined by epithelium will persist and will have a continuous discharge. This condition is perhaps not uncommon in chronic osteomyelitis with cavitation but a review of the literature failed to yield reports of similar observations.

CASE REPORTS

CASE 1. B. O. H. (2594), admitted to the University of Chicago Clinics February 2, 1928. White male, aged 63 years, had suffered from chronic pyogenic osteomyelitis of the lower portion of the right femur since the age of 12. This began spontaneously with redness, pain, swelling, and fever. Following operation, a draining sinus persisted laterally above the knee. At 18, another operation was performed after which the sinus remained closed until 1912, when because of severe pain a third operation was performed for drainage (rubber tubes used), and removal of dead bone. Since this date, 16 years ago, a discharging sinus has persisted at the site of the last operation.

Physical examination revealed nothing special aside from the right thigh. It was larger than normal in the lower half and on the lower lateral surface there was a linear scar 8 centimeters long and a sinus with raised rolled edges from which profuse foul smelling pus was discharged. On the lower medial surface of the thigh were healed linear scars. There was thickening of the periarticular tissue of the right knee and some atrophy of the right leg muscles.

Roentgenograms (Fig. 1) of the right femur showed shadows of an irregularly thickened cortex and an area of irregularly reduced density along about 5 inches of the medullary canal suggesting a cavity. Near the middle of this area were two dense shadows suggesting the presence of rubber tubing. In the lower part of the cavity were dense irregular shadows three of which were sharply circumscribed suggesting free bodies, while a large irregular one had a more diffuse outline.

Operation was performed on March 12, 1928, under ethylene anæsthesia. A lateral incision was made from the external condyle extending upward for 20 centimeters passing through the sinus. The lateral portion of the femur exhibiting a sinus through the cortex was exposed. On chiseling away the sclerotic cortex of the posterior inferior half of the shaft, a cavity was opened which contained a purulent exudate, two fragments of old rubber tubing, and several irregular dark brown, brittle, porous sequestra (Fig. 2). The cavity had a thick, fibrous lining in most of its extent which was easily curetted away and several irregular dark brown, sclerotic fragments bordered on its walls and were attached to underlying bone. They were evidently in the process of sequestration. After thorough evacuation and "craterization" of the cavity, it was packed with gauze and the upper portion of the wound sutured. Convalescence was uneventful but a sinus persisted.

The patient was last seen on April 10, 1930. A large discharging sinus was present in the lower lateral portion of the thigh. There was pain in the limb necessitating 30 to 40 grains of aspirin a day for relief. A forceps was inserted deeply into the sinus and several small fleshy fragments of tissue were removed from the opposite wall and examined microscopically.

Pathological study.[1] Sections were made from three different fragments of the soft, fleshy lining of the cavity removed at operation March 12, 1928. These were composed of dense fibrous tissue in which there were diffuse leucocytic infiltration and scattered large foci of lymphocytes with true germinal centers. Along one margin of the sections were small stretches of mature, stratified, squamous epithelium, exhibiting stratum germinativum and stratum malpighii but no superficial horny layer. No hair follicles or sebaceous glands were seen. One section (Fig. 3) showed a rather long stretch of epithelium continuous on each side with a layer of granulation tissue (pyogenic membrane). Thus, the cavity appeared to have been lined in part by islands or sheets of stratified squamous epithelium.

Sections through sequestra (Fig. 4) showed them to be composed of dead bone, in the large marrow spaces of which were finely granular calcareous deposits, much denser in some places than in others. In places, this deposit had a definite lamellar appearance (see microscopic findings in Case 3) strongly suggesting calcification of dense bundles of collagenic tissues. In other places the deposits were about islands that had been occupied by fatty marrow. Mixed with the calcareous material was considerable dark brown granular precipitate. This was also deposited on the surfaces of the bony trabeculæ thus accounting for the dark color of the sequestra. It was thought that the dark color might be due to the presence of iron sulphide or hemosiderin, but when sections were immersed in acidified potassium ferrocyanide solution, the Prussian blue reaction was not obtained.

Microscopic study of the minute fragments of tissue removed from the wall of the cavity opposite the sinus in April, 1930, showed them to be composed of stratified squamous epithelium, demonstrating that extensive epithelization of the cavity had recurred in the 2 years since operation (Fig. 5).

[1] In all histological studies in this report, the blocks of tissue were fixed in 10 per cent formalin solution, and if soft were embedded in paraffin. Blocks containing bone were decalcified after fixation in 5 per cent nitric acid in normal saline solution and embedded in celloidin. The stains used were Ehrlich's hematoxylin and eosin.

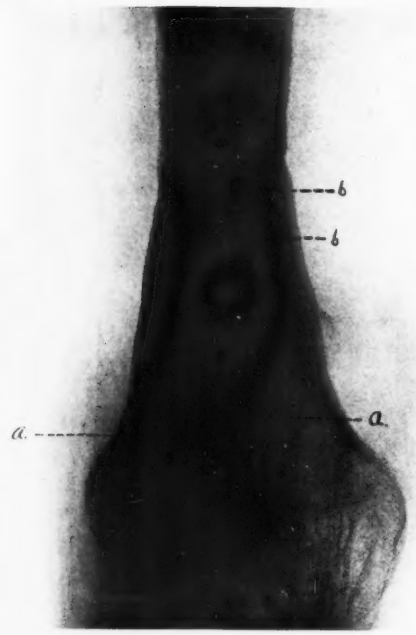

Fig. 1. Case 1. Roentgenogram of lower portion of right femur showing, *a*, multiple dense sequestra and, *b*, fragments of rubber tubing. Note expanded marrow cavity, thickened cortex of shaft, and atrophy above the knee.

Case 2. T. N. M. (9450), admitted to the University of Chicago Clinics January 25, 1929. When about 8 years old, patient developed acute osteomyelitis of the lower portion of the right femur and of the upper portion of the right tibia which led to the formation of several discharging sinuses. Small pieces of bone were extruded from the sinuses over the tibia; these sinuses closed after "cauterization." The knee joint then opened spontaneously and the patient did not walk until he was 14. At the age of 25, an operation was performed "for scraping the bone." All sinuses then closed and remained so until at the age of 47, following an attack of measles, a flare-up of the process in the lower portion of the femur necessitated incision and drainage. After that time there was a persistent sinus. Pain became an outstanding symptom, and in 1914 a third operation was performed. The patient had been irrigating the sinus above the knee twice a day for 15 years, but no improvement had resulted.

On physical examination, the right inferior extremity appeared somewhat enlarged in diameter but was 4 inches shorter than the left. There was a large indurated area over the lower half of the leg with an ulcer in it. On the posterolateral surface of the lower third of the thigh there was a depressed discharging sinus through which a probe could be passed into a large cavity in the bone. The femur was bowed slightly inward and on palpation a marked thickening of the shaft at this level was found. Very little motion was present in the knee joint. The foot was held in talipis equinis and there was about 25 degrees' motion present in the ankle joint. Urine was negative. Congo red tests showed 25 per cent absorption.

Fig. 2. Case 1. *a*, *a'*, *a''*, *a'''*, Dark colored sequestra removed from within cavity in femur; note coarse granular and porous appearance. *b*, Portion of yellow sclerotic cortex for contrast with the above. *c*, Fragment of bone from lining of cavity showing *x*, dark portion apparently dead bone still attached to *y*, underlying yellow living bone.

Roentgenograms showed extensive old osteomyelitis of the distal half of the right femur. An old window was present through the cortex of the posterior portion of the lower shaft. There was considerable periosteal bone formation and one small sequestrum lying in the soft parts anterior to the femur. There was marked atrophy of bone above the knee.

Conservative treatment was out of the question. Amputation of the right inferior extremity, below the upper third of the femur, was performed on February 8, 1929. Convalescence was essentially uneventful and the wound was healed in 6 weeks. The patient died suddenly 4 months later; no other details available.

Pathological studies (confined to lower portion of femur). When the soft parts were removed from the lower two-thirds of the femur, the cortex were found to be markedly roughened and exhibited a number of sharp irregular ridges. There was considerable marginal lipping of the inferior articular surface and extensive erosions of the cartilage at the weight-bearing points. Perforating the cortex of the shaft on the posterolateral aspect, 11 centimeters above the knee joint, was an oval window 6 centimeters long and 2.5 centimeters wide plugged firmly by dense fibrous tissue in the center of which was a funnel-shaped patent sinus leading into an elongated cavity 7 centimeters by 3 centimeters in the central portion of bone (Fig. 6). The lower half of this cavity exhibited a grayish, dull smooth lining resting upon a rather thick layer of dense, pearly fibrous tissue. In the upper portion, the wall of the cavity was markedly roughened and was composed of brittle discolored bone partly covered by a thin layer of granulation tissue.

Sections through the deeper portion of the tissue showed it to be lined with mature stratified squamous epithelium

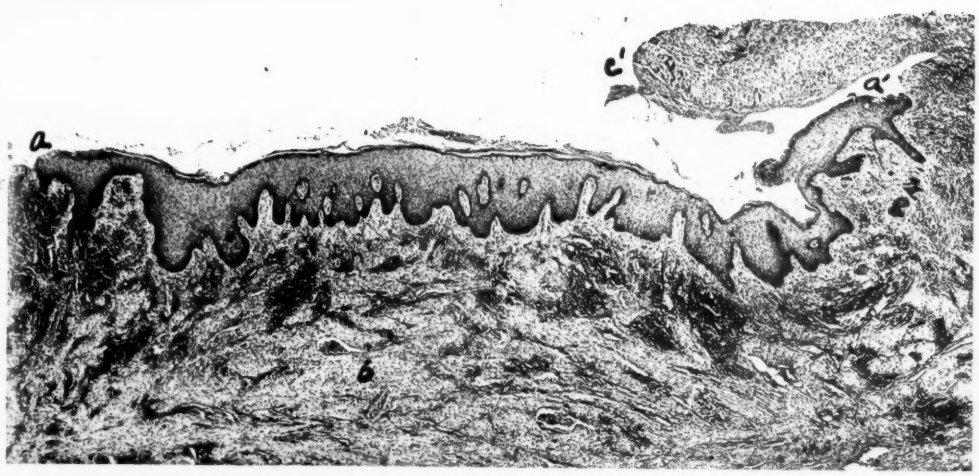

Fig. 3. Case 1. Section showing *a*—*a'* "island" of mature stratified squamous epithelium from lining of large cavity in femur. *b*, Densely infiltrated fibrous tissue. Note *c*—*c'* pyogenic membrane lining cavity in which there is no stratified squamous epithelium. ×20.

Fig. 4. Case 1. Section from one of the dark colored sequestra of dead bone found loose in the marrow cavity. *a*, Finely granular calcareous deposit denser in some places than in others. *b*, Calcareous deposit exhibiting a dense lamellated appearance. *c*, Dark brown precipitated material mixed with granular calcareous deposit and lining surfaces of bony trabeculæ. ×70.

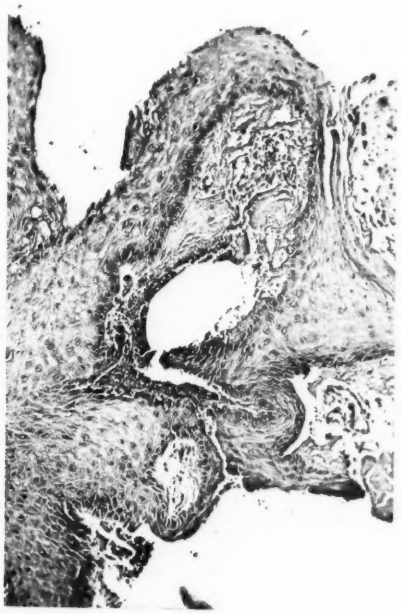

Fig. 5. Case 1. Section of fragment of stratified squamous epithelium recovered from deep lining of cavity 2 years following last operation. Epithelization of the cavity has thus recurred during this period. ×70.

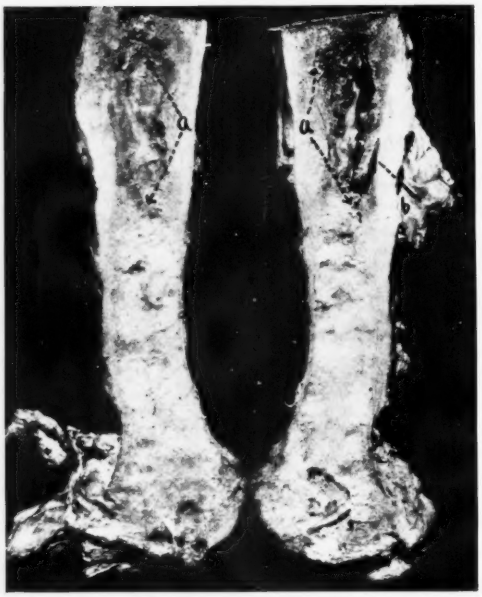

Fig. 6. Case 2. Gross specimen of inferior half of right femur showing *a*, central cavity with large sinus through cortex in posterior portion, *b*, sinus tract surrounded by dense fibrous tissue leading into cavity.

resting upon infiltrated dense fibrous tissue (Fig. 7). Other sections showed that this epithelium extended into the cavity, lining the inferior posterior portion, and was continuous with the lining of the remainder of the cavity which was seen to consist of a typical "pyogenic membrane" (Fig. 8). The epithelium in the cavity differed decidedly from that lining the sinus. In the former the cells were all quite large and irregular; in places there was no definite stratum germinativum but slender processes of epithelial cells were seen to extend into the subjacent layer of fibrous tissue and for a little distance over the neighboring pyogenic membranous lining. Here the appearance of the epithelium suggested active proliferation. In the epithelium lining the sinus, the cells were all smaller, there was a definite stratum germinativum and stratum malpighii and a wide keratohyaline zone. The regularity in arrangement and size of the cells in the basal layer indicated no proliferative activity. The upper portion of the cavity was lined by bone and granulation tissue.

Case 3. H. A. W. (1674), admitted to the University of Chicago Clinics January 17, 1930. White, male, aged 65 years, lawyer. At the age of 12 he developed osteomyelitis of the lower half of the left femur. Following incision and drainage, a discharging sinus persisted for the next 6 years. Operation was then performed for further drainage of "abscess" and curettage of bone. A year later, two more incisions were made with removal of dead bone on each occasion. The sinus then closed and remained so for 25 years, during which time the patient had occasional attacks of pain in the thigh but there was no deleterious effect on his general good health. In 1910, 32 years after the original trouble, there was a return of symptoms and a

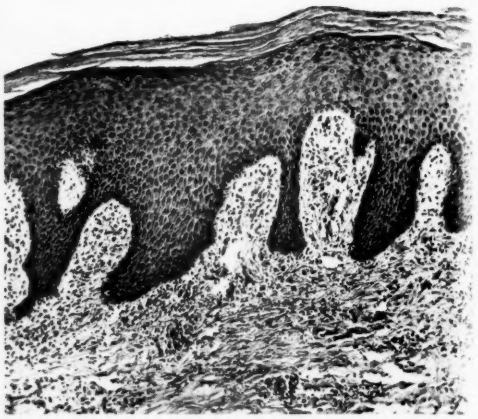

Fig. 7. Case. 2. Photomicrograph of lining of sinu leading into bony cavity from the surface of the thigh stratified squamous epithelial lining. Note mature an inactive appearance of the epithelial layer. ×55.

roentgenogram showed a "bone abscess in the lower por tion of the left femur." This was again opened and drained with curettage of surrounding bone. Since that time th sinus has persisted and the femur has been operated upo four times; in 1915, a "bone plug" was inserted and i 1917, the "lining of the cavity was cauterized." At the las operation in 1922, there was extensive removal of bon walls but a discharging sinus reformed. Since 1913 the patient has had diabetes melitus. In the last 3 or 4 months there has been marked increase in the foul purulent dis charge, loss of strength in the left leg, and inability to stand long without much pain. These complaints have very seriously interfered with the patient's ability to work.

Physical examination revealed on the lower lateral aspect of the left thigh a scar 20 centimeters long, in the central depressed portion of which was a sinus 5 centimeters long, draining foul pus. The skin about the scar was hyperæmic and the deeper soft tissues were œdematous and tender. A probe could be readily passed through the sinus into an underlying bony cavity. Scars were also present in the lower medial aspect of the thigh and in the popliteal region. Extension at the knee joint was limited to 150 degrees and flexion to a little more than 90 degrees. There was no pain or tenderness about the knee nor fluid within the joint. The spleen, liver, and kidneys were not enlarged, and there were no other physical findings relative to the disease. Urine analysis showed albumin, sugar, but no acetone bodies. Blood sugar examination showed 181.8 milligrams per 100 cubic centimeters of blood.

Roentgen ray examination showed old osteomyelitis with sclerosis and cavity formation in the distal half of the left femur. The articular space in the knee joint was greatly narrowed and showed roughening of the approximating portions of the tibia and femur, particularly over the lateral side.

Because of the foul smelling discharge, the recent flare-up of the process, and the great distress caused to the patient, amputation through the middle half of the femur was performed on January 21, 1930, under ethylene anæsthesia. The wound healed rapidly and the patient's general condition was satisfactory throughout convalescence. He was discharged on February 8, 1930, and three days later would

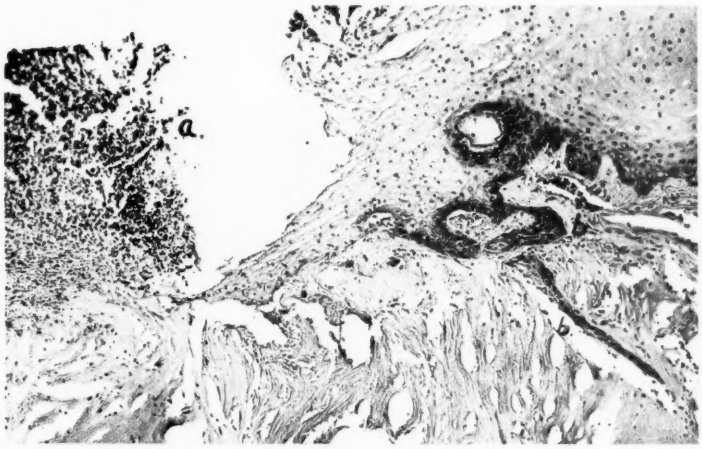

Fig. 8. Case 2. Section through margin of epithelial lining in the lower portion of the cavity in the femur. *a*, Pyogenic membrane of remaining portion of lining. Note proliferative appearance of epithelium here in comparison with that in Figure 7, which lines the sinus. *b*, Processes of epithelial cells extending into subjacent dense fibrous tissue. ×65.

was received that he had died suddenly, from pulmonary embolism.

Pathological study. The lower half of the femur, disarticulated from the tibia and freed of soft parts, exhibited a very thickened adherent periosteum over a roughened cortex. There was marginal lipping about the inferior articular surfaces. The cartilage itself was markedly thinned at the points of contact with the articular surfaces of the tibia and patella (weight-bearing points), and in spots appeared absent altogether. On the lateral aspect of the lower portion of the shaft there was a sinus 8 centimeters long and 1.75 centimeters wide with rolled margins communicating with the marrow cavity. When bisected, the lower portions of the shaft exhibited an elongated cylindrical cavity 9 centimeters in length and 1.5 centimeters in diameter which expanded at its lower end into an Erlenmeyer flask shaped cavity 3 centimeters in diameter at its base in the metaphysis (Fig. 9). The large sinus through the lateral portion of the shaft described above led into the upper cylindrical portion of this cavity. The cortex of the shaft about the cavity was about 1 centimeter thick and the medullary cavity was filled with new bone. In the central portion of the shaft a short distance above the cavity, there was a patch of fibrous marrow, the central portion of which was calcified. In the metaphysis below the cavity, the cancellous bone was quite porous and filled by fatty and hemopoietic marrow.

The cavity itself was filled by foul smelling purulent material, containing two irregular spiculated black, calcareous masses. When the contents were cleared away, the cavity was seen to be lined by a pearly gray, fibrous, rather tough membrane, quite distinct from the bone and measuring 1 to 2 millimeters in thickness. This lining was everywhere intact except at both extremities of the cavity where it appeared to be perforated by dark brown-black, brittle, short, calcareous spicules, projecting into the lumen. These, on the other hand, were closely adherent to the underlying bone and because of the gross resemblance to the free bodies mentioned above, conveyed the impression that they were similar structures in the process of detachment from the wall of the cavity. At one point the lining was raised but not perforated by a small nodule of dark brown bone. The cartilage on the superior articular surfaces of the tibia and patella was also roughened and markedly thinned or absent in the "weight bearing areas."

Sections from the wall of the cavity taken from widely separated points and from the inner opening of the sinus, showed a stratified squamous epithelial lining of variable thickness (Fig. 10). Beneath this was a zone of dense fibrous tissue throughout which were scattered numerous small blood vessels and diffuse and focal infiltration by leucocytes, mainly polymorphonuclears and lymphocytes and at one point a focus of foreign body giant cells.

The stratified squamous epithelium here again exhibited no superficial horny layer, the most superficial cells were flattened but their nuclei stained heavily and the cell outlines were still distinct. In places, however, occasional "pearls" were present in the stratum malpighii. Some sections showed rounded, empty, vacuolated areas also in the stratum malpighii (vesicles); no pigment was definitely seen anywhere in the stratum germinativum, and as in the previous cases, there were no hair follicles or sebaceous glands. Polymorphonuclear leucocytes were seen migrating into the epithelium. The lining was similar to the epithelial layer covering a healed scar on the surface of the body.

This lining of stratified squamous epithelium was discontinued in but two small areas, namely, at each extremity of the cavity where the brown-black spicules protruded into the lumen. Here there was acute ulceration of the epithelium about the spicules, which themselves were composed of dead, cancellous bone, in the marrow spaces of which there was a dense, calcareous deposit exhibiting in places a definite lamellated structure (Fig. 11). The spicules appeared to be undergoing sequestration from the wall of the cavity.

Sections through the free spiculated masses in the cavity showed them to be composed primarily of laminated

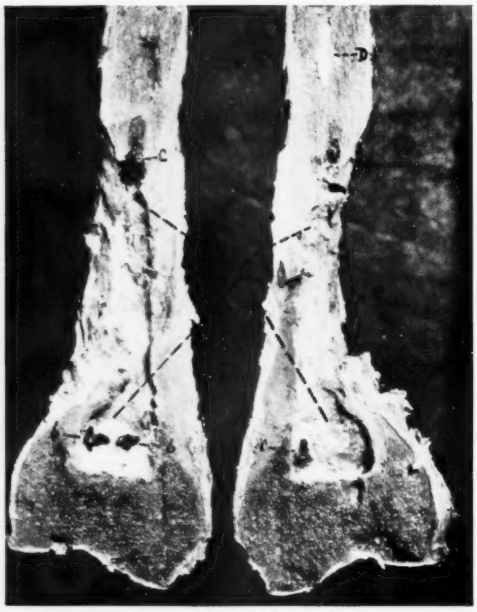

Fig. 9. Case 3. Gross specimen. Bisected lower half of left femur showing *a*, large cavity in shaft and metaphysis with whitish fibrous lining (epithelium); *b*, loose black spiculated bodies in cavity; *c*, dark spicules of bone perforating epithelial lining at points of ulceration, and seemingly being detached; *d*, patch of fibrous marrow with calcified center; *e*, sinus.

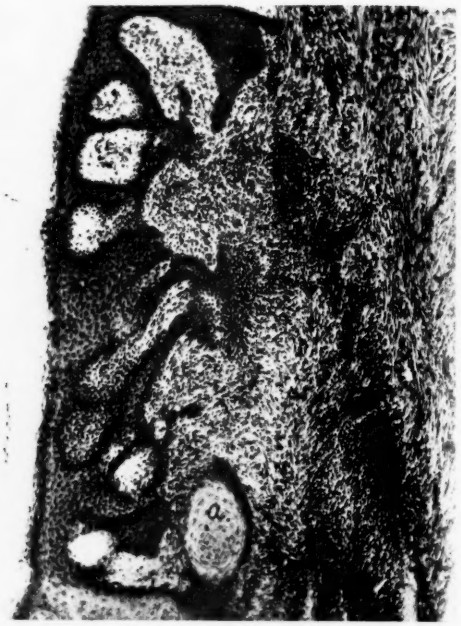

Fig. 10. Case 3. Section showing stratified squamous epithelial lining of lower portion of cavity. *a*, Large epithelial pearl. The fibrous connective tissue beneath the epithelium is densely infiltrated by leucocytes. ×65.

calcareous deposit throughout which were scattered a few small fragments of dead bone (Fig. 12). Over the external surface there was a brown discoloration which was not due, however, to hemosiderin, as again determined by the ammonium sulphide and Prussian blue tests.

In the patch of fibrous marrow above the cavity a sharply defined area of calcification was seen (Fig. 13). This deposit had a lamellar appearance and included no cell nuclei. It was in reality calcification of part of the fibrous marrow resulting from the osteomyelitis, the granules having been precipitated on bundles of collagen—hence the lamellated structure. Bordering this calcified area and within it were bony trabeculæ.

Sections through the articular surfaces of femur, tibia, and patella showed marked thinning or in places complete absence of the cartilage in the weight-bearing areas. At the margins, the articular cartilage was normal in thickness.

To repeat, the pathological changes of unusual interest in these three cases are: first, the partial epithelization of the osteomyelitis cavities; second, in Cases 1 and 3, sequestra composed partly of bone and partly of calcified fibrous marrow and fragments of similar nature undergoing sequestration; third, in Case 3, calcification in fibrous marrow of living bone some little distance from a large osteomyelitic cavity.

Aside from its presence in neoplasms, and in various tissues in obscure metabolic disturbances, pathological calcification is a manifestation of senility and also occurs at the site of old healed granulomata or in soft tissues subjected to long periods of low grade inflammation where there is frank necrosis or considerable devitalization of tissue. Calcification is furthermore encountered in old scars of inflammatory origin such as the dense hyalinized fibrous tissue that follows the resorption of abscesses. That fibrous marrow in osteomyelitis presents no exception to this rule is well illustrated in Cases 1 and 3 reported.

A search of the literature fails to reveal the report of calcification in fibrous marrow and fibrous lining of old osteomyelitic cavities. This can scarcely be due to the rarity of the condition and must be explained by the infrequency with which such cavities have been subjected to detailed study. Calcification in the marrow of tuberculous sequestra has been noted by Phemister. Extensive calcification in the dense fibrou-

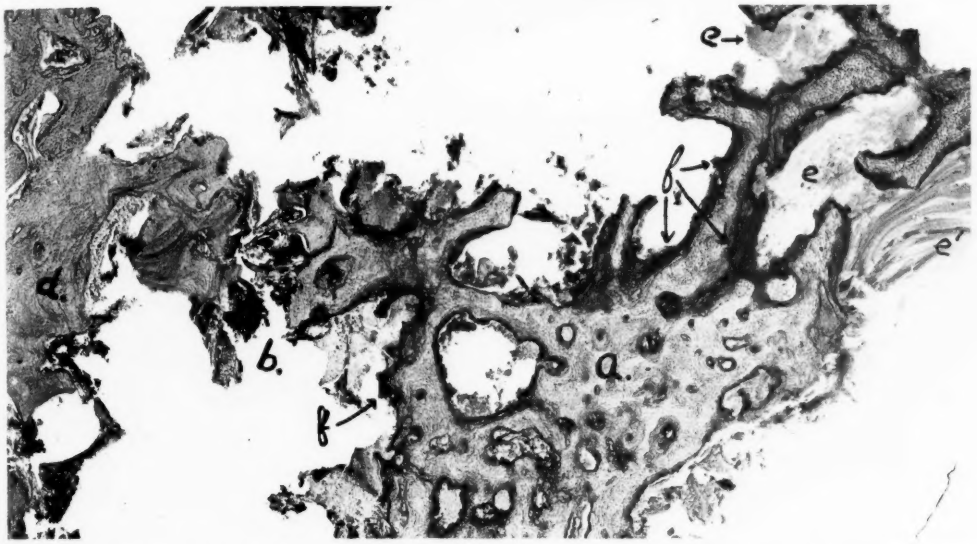

Fig. 11. Case 3. Section showing *a*, large fragment of dead bone (*c* in Fig. 10) undergoing sequestration from *d*, living bone. *e*, Calcification in marrow spaces. Note lamellate structure of deposit in one area, *e'*. *f*, Brown pigment deposited on surface of bone giving it dark colored appearance in the gross. ×15.

lining of an old bone cyst has been reported by the writer and also has been observed recently in the dense fibrous lining of an old osteomyelitic cavity in an amputated extremity.

Since only calcified sequestra are available for study in Case 1, it is difficult to state just when the calcification occurred in this instance. However, in Case 3 there are calcified sequestra, dead bone in the wall of the cavity with calcified marrow undergoing sequestration, and calcified marrow in living bone near the cavity. This would suggest that the calcification in all the sequestra may have occurred in the marrow of living bone near the cavity and that as the cavity extended

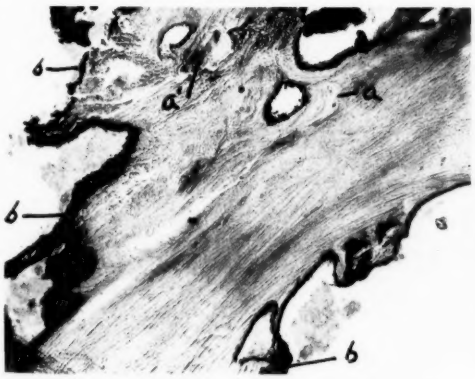

Fig. 12. Case 3. Section from dark colored sequestrum (*b* in Fig. 9). This is composed nearly entirely of calcified marrow. Note lamellar appearance of deposit suggesting petrified fibrous marrow. *a*—*a'* small fragments of dead bone. *b*, Dark brown pigment covering sequestrum. ×60.

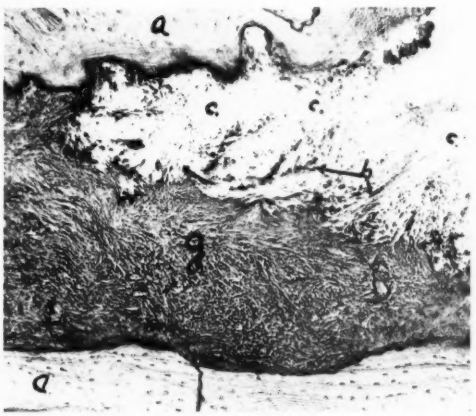

Fig. 13. Case 3. Microphotograph of section through portion of *g*, calcified fibrous marrow (*d* in Fig. 9). Note dense lamellar organization of calcareous deposit. *a*, Living bone. *b*, Small bundles of collagen in which calcareous deposit has taken place. *c*, Fibrous marrow. ×65.

to these areas, the bone about the calcified marrow became devitalized, the whole mass then undergoing sequestration.

The downgrowth of cutaneous epithelium to line chronic bronchial, biliary, and anal fistulæ is not an uncommon pathological finding. That stratified squamous epithelium may also proliferate to line chronic sinuses leading into bony cavities and that it may extend farther partially or nearly completely to line these cavities is well illustrated in all three of the cases which have been reported.

In the walls of the cavities where epithelization is extensive (Cases 1 and 3), the epithelium has a somewhat mature appearance. In Case 2 in which the epithelium is limited to a small area, it appears to be proliferating in attempt to extend further over the wall of the cavity.

The epithelial lining of these cavities no doubt was a factor in the prevention of healing, analogous in a way to the failure of pilonidal or sebaceous cysts to heal when even a minute fragment of the old lining is left behind at operation. On the other hand, epithelization of the walls of large bony cavities in osteomyelitis by Thiersch grafts (Lord) and by Reverdin grafts (Reid) has been recommended as a means of treatment. In these instances, however, emphasis is placed upon a preliminary conversion of the cavity into a crater or trough by chipping away as much of the walls as possible. As already stated, a cavity with *small communication to the outside*, even though it is completely lined by stratified squamous epithelium, does not heal, for accumulation of bacteria and débris within it results in continued inflammation in the surrounding tissues.

Finally, mention may be made of the fact that epidermoid carcinoma not infrequently develops at the site of old chronic discharging sinuses in osteomyelitis. Downgrowth of stratified squamous epithelium into these sinuses in which the inflammatory process affords the stimulus to malignant degeneration of the epithelial cells may be the explanation for this.

TREATMENT

In two of the three cases cited above, the inconvenience and pain caused by the lesions over a period of so many years and the obvious hopelessness of further conservative treatment, made amputation an advisable procedure. Unfortunately, neither of these two patients survived the operation for very long. In the third case, where more conservative treatment was employed, the cavity being extensively effaced by removal of much of its walls and all sequestra, foreign bodies, and soft parts, no relief from pain or purulent discharge was obtained. The condition of the leg remained essentially the same as before operation. In fact, the cavity had become relined with epithelium at the end of 2 years and there appeared to be no reduction in its size and in the amount of discharge.

SUMMARY

A histopathological study of three cases of chronic pyogenic osteomyelitis of over 50 years' duration showed:

1. Epithelization of the draining sinuses and partial to nearly complete epithelization of the large cavities in the bone to which they led.
2. Calcification of fibrous marrow in cancellous bone bordering the cavities, with infection and necrosis and partial or complete sequestration of these bony and calcified areas.
3. Calcification in fibrous marrow away from the epithelized cavities, surrounded and traversed by living bone.

NOTE.—The author wishes to thank Dr. D. B. Phemister for help and suggestions in the pathological studies.

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SERIOUS INTRA–ABDOMINAL TRAUMA WITHOUT EXTERNAL EVIDENCE OF VIOLENCE[1]

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THERE is a group of surgical conditions of unusual interest and importance in that they are not amenable to the ordinary routine for diagnosis, yet are of such urgency that on the early and correct determination of the character of the lesion a favorable or fatal outcome depends.

As surgeons we feel commendable pride in such ability as we may possess to make correct preoperative diagnoses. We hesitate to do exploratory incisions and apologize when we consider the procedure necessary. And this is as it should be. To suggest then that there are a group of conditions which demand immediate operation, on the basis of our inability to say that certain lesions do *not* exist, rather than on our ability to say that they *do* exist, is radical, and calculated to bring the proponent a full measure of criticism. Nevertheless, this suggestion is made and the discussion following will be an endeavor to establish the soundness of the proposition.

Those lessons which we have learned from experience we do not forget, nor should we underestimate their importance. The material on which this discussion is based is collected from the author's personal observation. Certainly it cannot vary greatly from the experience of other general surgeons, who have been in the field long enough to make deductions. The conclusions reached from individual experiences may differ greatly, and therein should lie the value of this presentation. Our own conclusions are that in border-line conditions of the character which we are considering, prompt explanation is mandatory and there should be few exceptions to the rule.

We propose to consider the intra-abdominal traumas of a serious nature which are caused by external violence of such character as to leave little or no external evidence of injury. Such lesions are not infrequent; they are often such as to be certainly fatal without prompt surgical intervention, and the symptoms attending them may be so confusing as to make an early diagnosis impossible. Under these circumstances the problem is difficult. We cannot make a diagnosis by

Fig. 1. Woman aged 24 years. Severe crushing over upper abdomen with no external lesion, from train striking auto. Seen within 1 hour with evidence of severe shock and suspicion of intra-abdominal hæmorrhage. Immediate exploration with finding of ruptured liver as illustrated. Closure of fissure by mattress sutures with control of hæmorrhage. Recovery.

[1]Read at Pacific Coast Surgical Association, Del Monte, California, February 6, 7, 1930.

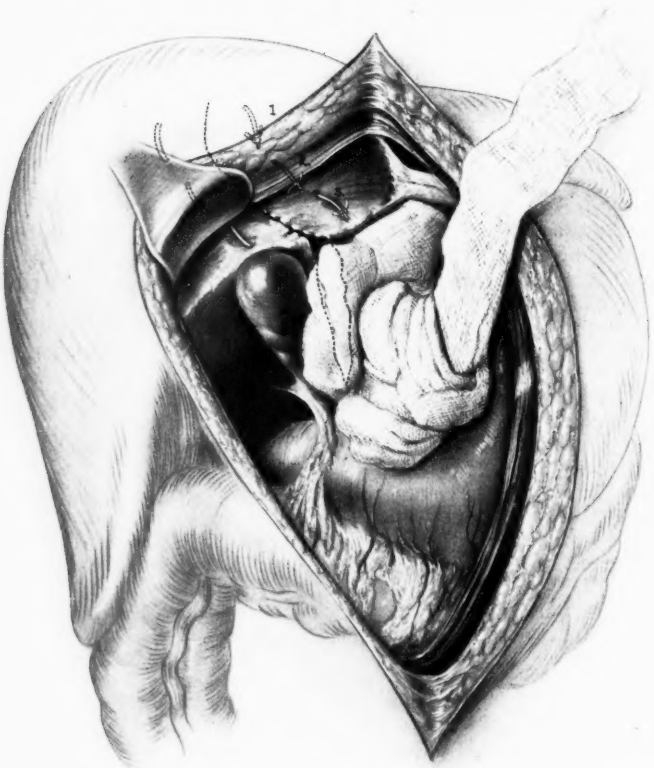

Fig. 2. Male aged 23 years. Severe crushing over upper abdomen with no external evidence of trauma. Seen 3 hours after injury in extreme shock and evidence of intra-abdominal hæmorrhage. Immediate exploration. Fissure could be only partly closed by mattress sutures and packing with gauze necessary to control hæmorrhage. Complete recovery after tedious convalescence.

conservative methods. If we explore we may find that the condition is non-surgical. If we do not explore we may deprive the patient of his chance to live. On what, then, shall we base our decision for action? It would seem that it should be determined by the selection of that procedure which, if we are in error, will be attended by the least serious consequences. An error on the side of conservation, when surgery is required may cost a life. The logic of the situation would seem to compel a decision for the radical procedure when serious doubt exists.

Before taking specific instances illustrative of the problems, it will be helpful to review the intra-abdominal factors, both anatomical and mechanical, which are pertinent to the discussion.

The organs of the abdomen liable to trauma from indirect violence may be roughly placed in two groups: namely, those which are solid and relatively fixed in position, and those which are hollow and less positively placed. These characteristics—consistency and mobility—are factors that must be borne in mind if we are to hope for correct deductions as to the exact nature of lesions, the known factors being only the nature of the violence and the subsequent physical signs.

The solid organs that interest us in this discussion are the liver, spleen, pancreas, and diaphragm. The hollow organs entering into the picture are the stomach, small and large bowel, the urinary bladder, and the blood vessels. The author has seen fatal, or potentially fatal, lesions

Fig. 3. Woman aged 45 years. Auto accident causing severe crushing over upper abdomen. Seen 4 hours later with evidence of extreme shock and intra-abdominal hæmorrhage. Immediate exploration. Multiple ruptures of spleen. Mattress sutures as illustrated controlled hæmorrhage. Convalescence perfect until fourteenth day when sudden death after patient was dressed for dismissal. No autopsy. Presumably death from embolus. Query: Would splenectomy have been a safer procedure?

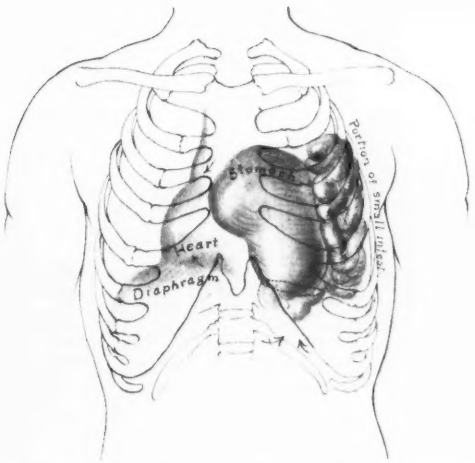

Fig. 4. Male aged 42 years. Thorax and upper abdomen crushed in auto accident. Seen 2 hours after injury in great shock with fractured ribs and obvious pneumothorax and hæmatothorax right. Condition too critical to permit gastro-intestinal series. Dismissed after 5 weeks, improving. Returned 3 weeks later with severe indigestion and cardiac attacks. Investigation demonstrated diaphragmatic hernia, left, as illustrated. Operation pending. (Drawing from radiograph taken 15 minutes after barium meal.)

of each of these structures one or more times from transmitted violence of such character as to leave practically no external evidence of injury. This experience convinces him that preventable deaths (preventable assuming prompt surgical intervention) are sufficiently numerous to warrant serious attention to the subject. And further, the experience teaches that prompt intervention is *not* the rule and that the percentage of fatalities is distressingly high. The liver and spleen are organs with very similar gross characteristics. Both are held in a relatively fixed relation to surrounding structures. Each is enclosed by a delicate capsule —so delicate that it is easily torn by any sudden increase in intracapsular tension. The parenchyma with each is soft and friable, not permitting any great alteration in contour without a severance in one or more places in its continuity. By reason of their glandular functions they are exceedingly vascular. Finally each organ at its upper pole has the indifferent protection of the lower part of the thoracic cage, while at the lower pole there is no protection except by soft tissues, a guarantee altogether inadequate against such violence.

Under these conditions we would anticipate rupture of the organs from crushing injuries which might not be sufficient to leave local external signs, particularly from blunt violence applied over their lower poles from below upward. It is less remarkable that such accidents do occur than that they are known to occur so infrequently. Experience compels the conviction that the incidence of these accidents is greater than is generally supposed, and that many fatalities occur from them, the nature of which is often not determined and less frequently reported.

Figures 1, 2, and 3 illustrate the conditions found with rupture of the liver and spleen. A brief case history is appended with each.

The pancreas is so situated as to be well protected, yet rupture of this organ is probably less rare than is generally supposed. Within the last month we have had as a patient a woman of 39 years who was brought to us in great shock following an automobile accident. Her extreme

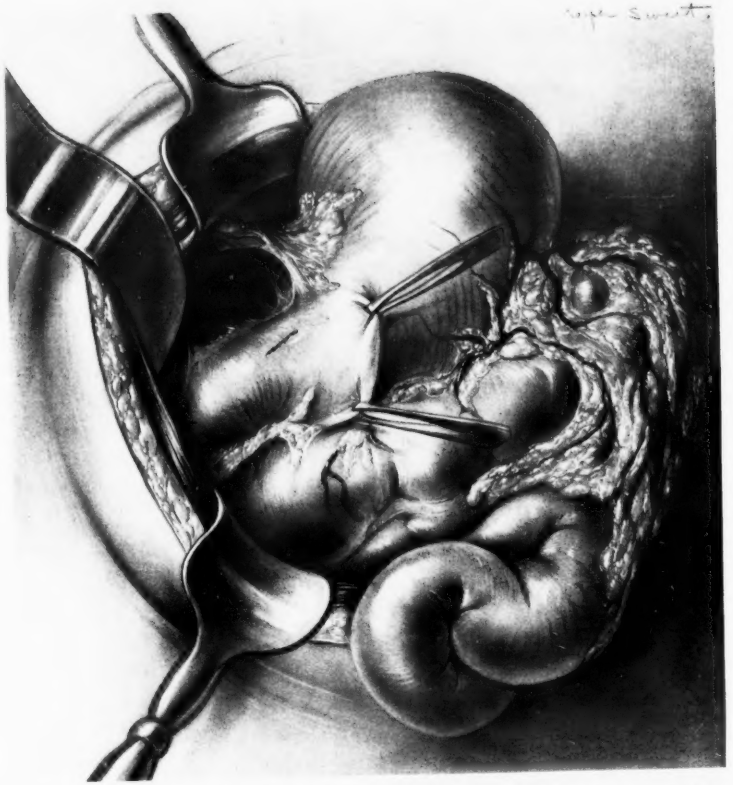

Fig. 5. Male aged 65 years. In auto wreck in Texas. Struck over upper right abdomen by steering wheel. Severe pain but proceeded to California by train. On the seventh day sudden onset of abdominal pain in all respects similar to syndrome following perforated duodenal ulcer. Seen by us 24 hours later. Immediate exploration advised. Laceration opening second portion of duodenum demonstrated—with general peritonitis. Death from general peritonitis.

Fig. 6. Male aged 35 years. Motorcycle accident. Struck over upper abdomen, no evidence of external trauma. Seen within 1 hour. Patient in shock with evidence of intra-abdominal bleeding. Immediate exploration was urged. Advice was refused. Three days later operation was permitted but the patient was *in extremis*. At operation the jejunum was found completely severed a few inches from its origin, as illustrated. Death occurred from general peritonitis.

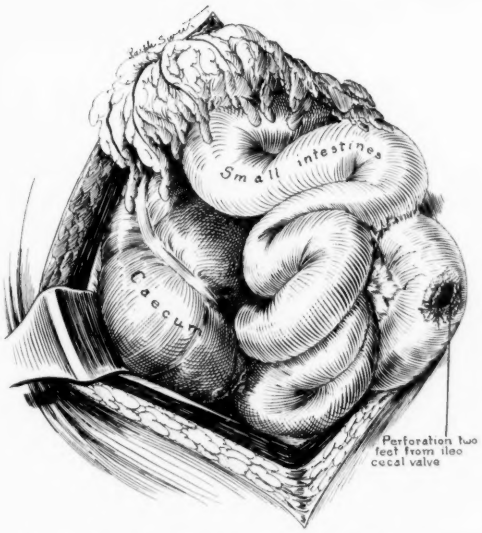

Fig. 7. Male aged 30 years. Knocking fruit from tree with long pole which slipped and struck him over lower abdomen. Immediate severe pain but no objective sign of injury. Held under observation by his physician for 2 days, then sent to the clinic. Diagnosis of ruptured bowel with peritonitis. Immediate operation. Perforated ileum as illustrated with general peritonitis. Death from general peritonitis.

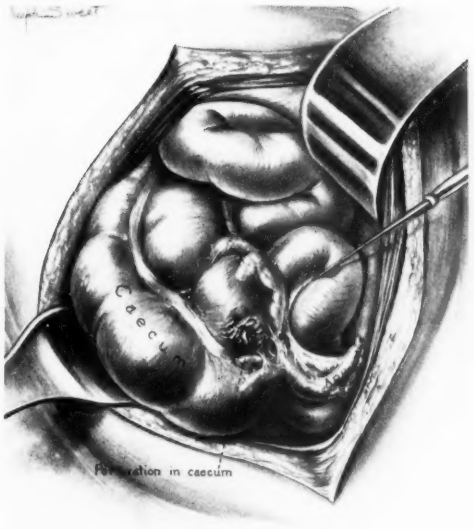

Fig. 8. Male aged 9 years. Thrown from motorcycle striking lower abdomen against a post. No external evidence of injury. Treated by his family physician for 3 days, then brought to the clinic. Diagnosis of ruptured bowel with peritonitis. Immediate operation. Cæcum found ruptured as illustrated. Death from general peritonitis.

condition seemed to preclude the possibility of her surviving exploration. Transfusions improved her condition but slightly. She died on the third day and postmortem examination disclosed no serious lesion except a lacerated pancreas with characteristic fat necrosis. Query: Would drainage have altered the outcome?

The diaphragm is potentially subject to rupture, hernial in character, exactly as is the wall of the lower abdomen at the exits of the spermatic cords. That spontaneous ruptures occur so infrequently is due to the superior position of the organ freeing it from the direct strain of gravity. But, having the potentialities for herniation, it is not remarkable that when the one normally absent factor, namely pressure from below upward is supplied as with compression injuries the accident not infrequently occurs. Such lesions are serious and personal experience teaches that they may be easily overlooked if one is off guard for the possibility of their occurrence. The X-ray with opaque meal establishes the diagnosis. Unfortunately, as in 2 cases coming under our observation, the patient's condition was such as to make this procedure inadvisable with the result that in both instances the diagnosis was made on readmittance some weeks later. Figure 4 illustrates the condition then found and a brief case history appended. The second case was in nearly all respects similar.

The hollow organs—the stomach, small and large bowels, the urinary bladder, and the blood vessels—have less in common than the organs of the solid group and cannot be discussed except individually.

The stomach like the organs already considered has a fair protection from the lower part of the thoracic cage. It has a considerable latitude in mobility, is strong walled and has a large lumen, all factors operating to keep it intact even in the presence of extreme violence. The author has never been privileged to see a ruptured stomach except in trauma so severe as to terminate life from causes not directly related to the stomach lesion.

The small bowel is so situated as to invite rupture from accidents such as we are considering. It has practically none of the protective factors possessed by the stomach. Portions of it are always between the anterior abdominal wall, which gives no protection against any considerable force applied from the front, and the spine posteriorly, which is a hard irregular body with fixed posterior

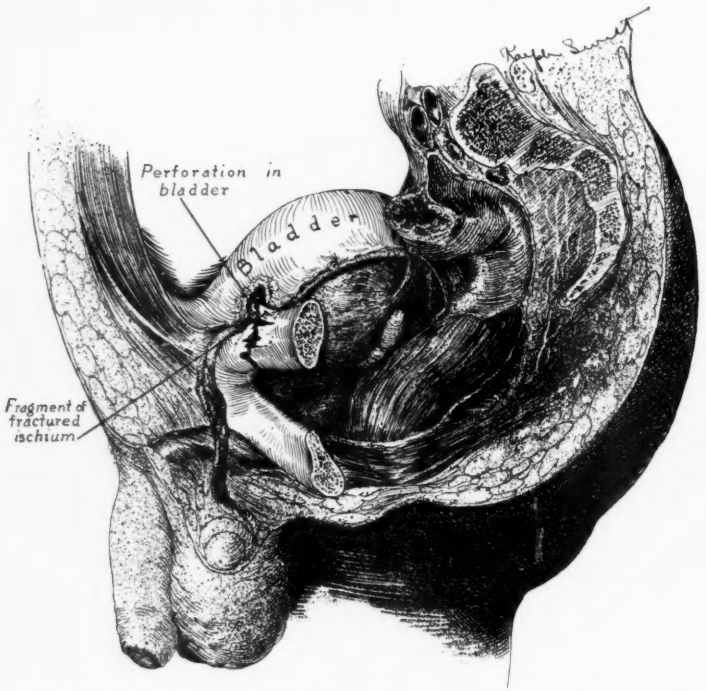

Fig. 9. Male aged 21 years. Pelvis fractured by overturned automobile. In a few hours small quantities of blood stained urine with œdema of scrotum and evidence of extravasation of urine into soft tissues led to diagnosis of rupture of the urinary bladder. Operation demonstrated puncture of bladder from spicule from fracture of the pubic bone. Closure of bladder defect. Recovery.

limits. The small intestine is a relatively delicate structure, so delicate that a force applied to the abdominal wall insufficient to mar it would yet be great enough to press the interposed small bowel against the spine with sufficient force partially or completely to sever its continuity. This accident we have seen twelve times, with death always from peritonitis where there was material delay from any cause. The difficulty in obtaining the consent of the patient and the family for immediate exploration is often insurmountable. The absence of objective evidence of serious injury is an argument to them so strong for conservatism that the advice by the surgeon for operation is overruled until, too late, the objective signs of peritonitis convinces them of their error (see Figures 5, 6, and 7, with appended short case histories, to illustrate the conditions).

In two instances from violence of the nature stated the actual perforation of the bowel was delayed for several days, the patient seeming in the interval to have been not seriously injured. The symptoms of delayed perforation with its classical signs led to immediate operation. The findings compelled the conclusions that the trauma had devitalized a spot in the intestine, perforation occurring only after gangrene of the area had resulted in its dissolution.

Perforations of the small bowel are in our experience found usually in the upper one-third, and observation in accord with that which would be expected from a consideration of the fact that the upper abdomen has no firm protection either anteriorly or laterally while the vertebræ in this location are most prominent. The lower abdomen is protected by the pelvis from both directions to a material degree, and the vertebræ are relatively less prominent.

The wisdom of careful observation extending over a period of some days of those patients who have suffered these accidents is suggested as necessary, this because the accident of late

Fig. 10.

Fig. 11.

Fig. 10. Male aged 31 years. Was directing a Fresno scraper holding the handles. The machine struck a stump jerking him violently. He felt immediate severe abdominal pain. No foreign body came in contact with his body. Pain continued and on the second day he was brought to the clinic. His temperature was normal and he seemed to be in mild shock with general abdominal tenderness and moderate abdominal distention. Exploration was not advised we being deceived by the character of the injury. On the fourth day he became suddenly worse with positive signs of acute peritonitis. Exploration revealed a circular clean cut perforation of the jejunum 1 centimeter in diameter 7 inches from the upper extremity of the jejunum. It is believed that the trauma caused an embolus in a small end artery with local gangrene and ultimate perforation. Death from general peritonitis. Prompt exploration would probably have saved his life.

Fig. 11. Male aged 50 years. Swabbing throat when he inadvertently swallowed wooden applicator 7 inches long. Three weeks later severe abdominal pain and symptoms of localized peritonitis. Exploration demonstrated the applicator had perforated the jejunum a few inches below its origin. The foreign body was removed and the wound closed. Recovery.

Fig. 12. Male aged 28 years. Had appendectomy 6 years previous to entry at which time he came to the clinic with acute obstruction at about the center of the small bowel. X-ray examination revealed presence of large Hagendorn needle in the abdomen. At operation the needle was found penetrating the small bowel and surrounded by a dense mass of adhesions. Resection of 4 inches of the bowel with uneventful recovery.

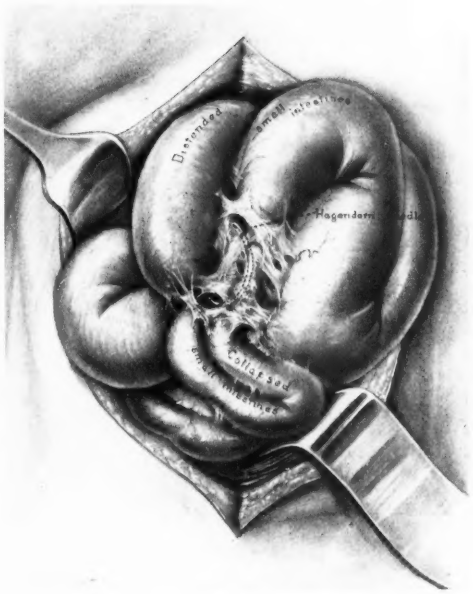

Fig. 12.

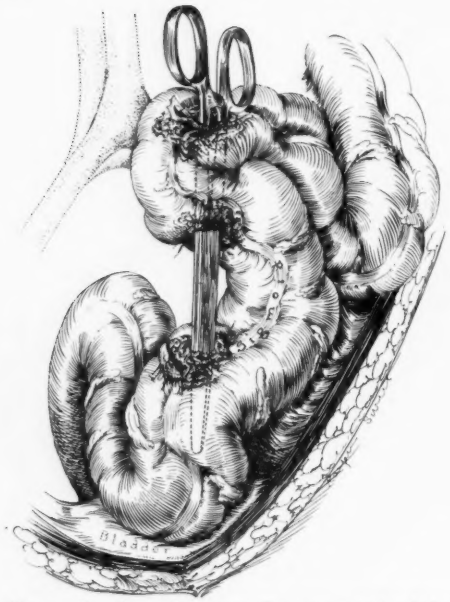

Fig. 13. Female aged 46 years. Ten years previously had had a hysterectomy followed by a stormy convalescence and continued intermittent abdominal pain. In the interval had seen several physicians and came to us with diagnosis of cancer of the large bowel. X-ray examination demonstrated 8 inch Kocher forceps in the abdomen. At operation instrument found entering and leaving sigmoid with the end again entering bowel at lower level. Resection of bowel with recovery.

Fig. 14. Female. At the age of 4 patient was kicked over the lower abdomen by playmate. Great pain and evidence of peritonitis—stormy convalescence—then continued extreme constipation, emaciation, and weakness. At age of 9 years was brought to clinic for diagnosis. A long hard cylindrical tortuous mass could be palpated freely movable in the central abdomen. Fæcalith suspected. Operation. Fæcalith in ileum 14 inches long distending bowel—spontaneous entero-enterostomy with stoma 1 centimeter in diameter and occurred immediately above the fæcalith which was of stony hardness. Resection of bowel with recovery.

perforation is, from our experience, not a remote probability and the surgeon should be on guard to meet the complication.

The large bowel is fortunately much less liable to serious injury from trauma than is the small intestine, though a rupture of the colon is a matter of much greater seriousness by reason of the increased danger of peritonitis. Fortunately, the colon is so placed as to suffer little likelihood of rupture from compression against the vertebræ except where its transverse portion crosses in front of the spine and this portion, again fortunately, is the most movable segment of the large gut permitting it usually to evade destruction from pressure. We have seen but one patient with a traumatic perforation of this organ, the lesion occurring from the effect of a blow, suffered during a motorcycle accident, over the right lower abdominal quadrant (Fig. 8).

The urinary bladder is well protected against external violence by the pelvis except when force is applied during a time of extreme distention of the viscus. Reports are numerous of rupture under these conditions, though such an accident happens not to have come within our personal observation. We have seen rupture of the bladder on two occasions in association with a fractured pelvis, an incidence great enough to permit our stressing the necessity of having in mind the possibility of this complication being present with every fractured pubic or ischial bone (Fig. 9).

The intra-abdominal blood vessels are organs subject to rupture (independent of the lesions already described) from violence more diversified in character than are any of the structures above considered. The fixed relation of certain vessels to the spine subjects them to compression rupture with immediately serious consequences. The possibility of embolism from trauma in a small or large end artery with remote complications from gangrene complicates the picture. The case (Fig. 10) reported would seem to indicate the possibility of this accident occurring from severe stress without the application of any crushing force. S

frequently does intra-abdominal hæmorrhage progress to a rapid or slow termination in death, and so impossible is it to determine symptomatically the source of seriousness of the hæmorrhage that it would seem not only justifiable but mandatory to explore every abdomen in which there is a reasonable suspicion of intra-abdominal bleeding or embolus.

There is another type of intra-abdominal accident, without external signs of injury, that should not be forgotten. These accidents are mentioned in passing, the intent being to stress the necessity of viewing the picture in proper perspective. We must always have in mind the fact that misadventures of the past may be the key to unlock the problem of the present.

We have seen numerous perforations of the alimentary canal from foreign bodies accidentally swallowed long before (Fig. 11), and perforations from without the alimentary canal inward by surgical instruments, relics of past operations, the foreign bodies having been inadvertently left within the patient's abdominal cavity (Figs. 12 and 13).

Obstructions may occur years after as a result of trauma of the character which we are considering. Without having in mind the possibility of these complications and without having the history of the remote injury before us, a diagnosis would not be possible (Fig. 14).

At this time it would seem proper to consider in detail the problem of diagnosis and treatment, but this would not be profitable. The author fully appreciates his inability to make differentiations with any higher percentage of success than his confrères and purposes only to provoke a discussion with the idea of determining whether, in border-line cases it is considered that we are justified in pursuing expectant treatment or whether it is agreed that the path of greatest security for the greater number lies along the line of immediate exploration.

SUMMARY

1. Certain forms of external violence result in fatal or potentially fatal intra-abdominal lesions without leaving external signs of injury.

2. In these conditions an early or accurate diagnosis is not possible. If doubt exists as to the presence or absence of serious lesions the path of greatest safety lies along the line of immediate exploration.

3. Lesions of the solid organs, spleen, liver, pancreas, and diaphragm are discussed.

4. Injuries to the hollow organs, stomach, small and large bowels, urinary bladder, and the blood vessels are discussed.

5. Lesions from past misadventures not violent in character may result in long delayed and serious complications.

THE RADICAL CURE OF HALLUX VAGUS (BUNION)

Subarticular Resection of the Head of the Metatarsal Bone

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IN hallux vagus we have an inward deviation of the big toe. Part of the articular surface of the head of the metatarsal bone has lost contact with the corresponding articular surface of the phalanx, because the head itself is pushed outward and is generally enlarged. The bursa, between the skin and bone becomes enlarged and inflamed, and it may rupture and become infected.

The best known procedures for the correction of these conditions are those of Barker, Riedel, and Mayo. We believe, however, that the technique to be described, although perhaps slightly more difficult to do than some of the others, has evident advantages, because it preserves the articular surface of the metatarsal bone, at the same time that it corrects the deformity. Thus we obtain an articulation anatomically normal and functionally very satisfactory.

TECHNIQUE

A description of the technique follows. The head of the metatarsal bone is exposed and the periosteum from the middle of the metatarsal bone to about ¼ of an inch of the articular surface is incised (Fig. 3). With a sharp thin periosteum elevator the periosteum is separated around the bone (Fig. 4). The articular surface is then detached from the bone (Fig. 5). This can be done very easily and without damage if some bone is left attached to the articular surface itself; the spongy bone offers little resistance to a sharp instrument. The head of the metatarsal bone is then cut away, sufficient bone being removed to straighten the big toe. The excess of skin is removed with the bursa, and the wound is closed. A splinter is applied and the wound is dressed with gauze impregnated with glycerine or alcohol. The toe is kept at rest until any inflammation has subsided. Then passive and active movements are started.

By this technique, as shown in Figures 6 and 7, the periosteum and articular surface have been separated from about half of the metatarsal bone. When the head is resected, the articular capsule with its synovia and the periosteum falls back and covers the rough surface of the resected bone, to which it will, in a short time, adhere. Thus the head of the metatarsal bone has been removed and the articular surface has been preserved. In fact, the relations between the phalanx and the metatarsal bone have been reconstructed in a manner that is anatomically normal. The only difference between the normal phalangometatarsal bones and its articulation and the reconstructed pha-

Fig. 1, left. Roentgenogram of foot before operation.
Fig. 2. Roentgenogram of same foot about 3 months after operation. Note bone formation under articular surface of metatarsal bone and normal appearance of articular interspace.

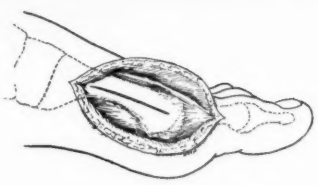

Fig. 3.

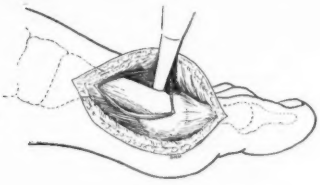

Fig. 4.

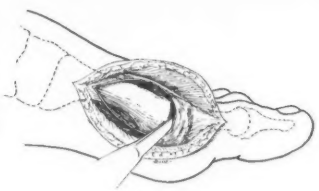

Fig. 5.

Fig. 3. Bone and joint exposed. Line of incision of periosteum.

Fig. 4. Periosteum elevator freeing periosteum around shaft of bone.

Fig. 5. Periosteum elevator freeing articular surface from head of metatarsal bone.

Fig. 6. Schematic drawing showing periosteum and articular surface detached from bone, along black line. Dotted line showing, roughly, portion of bone to be resected.

Fig. 7. Schematic drawing showing periosteum and articular surface falling back on metatarsal bone after its head has been removed.

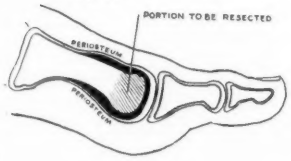

Fig. 6.

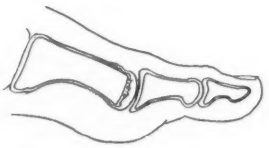

Fig. 7.

langometatarsal bones and its articulation is that in the latter the metatarsal bone is shorter.

We wish to remark that in two of our cases, the bursa had been incised several times following successive infections. We could not obviously employ the excellent Mayo procedure, so we attempted the operation described, and obtained the satisfactory results shown in Figures 1 and 2. Since then we have adopted the same technique in all our cases and the results have been most gratifying.

That the operation is anatomically and physiologically correct seems to us evident. That the results are functionally satisfactory is demonstrated clearly, especially by the case, the roentgenograms of which are reproduced in Figures 1 and 2. The patient was a professional dancer, and she was able to resume her dancing in less than 3 months after operation, notwithstanding the fact that the bursa had previously been repeatedly incised and infected before the radical operation was performed.

CONCLUSIONS

We feel justified in presenting to the profession a procedure in which hallux vagus may be radically cured, even when the bursa has been infected, by resecting the head of the metatarsal bone and preserving the articular surface, thus reconstructing a normal phalangometatarsal articulation.

ACUTE PERFORATED ULCERS OF THE STOMACH AND DUODENUM

Report of One Hundred Five Cases[1]

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Assistant Professor of Surgery, New York Post-Graduate Medical School and Hospital; Assistant Attending Surgeon, Bellevue Hospital; Assistant Attending Surgeon, St. Mark's Hospital

DURING the past 19 years, or from 1911 to 1929 inclusive, there have occurred on the Fourth Surgical Division at Bellevue Hospital 105 cases of acute perforated ulcers. Since starting the Gastro-Enterological Clinic of the Fourth Medical and Surgical Divisions in January, 1928, we have made every effort to get each of these cases back for observation. In analyzing the cases we have divided them according to year of occurrence to find out whether there is an increase in the frequency of perforated ulcers, and from Table I a definite increase since 1923 is shown. One frequently hears the statement made that the symptoms of chronic ulcers bear a definite seasonal relationship, recurring usually in the spring and fall of the year. From Table II one is impressed by the fact that in the spring and fall the frequency of perforations is much more common. One-fourth of the perforations occurred during the months of April and November. The histories have been studied carefully to determine what percentage of patients had histories of previous gastric disturbance, and also what number gave no evidence of gastric complaint until the time of perforation. It is often stated that 70 to 80 per cent of perforated ulcers occur in patients without a previous gastric history. In reviewing Table III it will be seen that our statistics do not bear out this assertion. Any case with symptoms of 10 days or less has been considered a negative gastric history. In our group of cases there have been only 2 acute perforated ulcers in females, while there have been 103 in males.

The cases have been divided into 3 groups: (1) deaths, (2) cases not followed, (3) cases under observation.

Group 1 is again divided into A, cases not operated upon; and B, those who were operated upon.

Group 1A. There were 5 cases in which death was due to a perforated ulcer although in 3 of these cases a clinical diagnosis was not made. See Table IV. Needless to say, if the patients had given sufficient symptoms to warrant a diagnosis of acute surgical abdomen, an exploratory laparotomy would have been performed. This group included 1 female and 4 males. The ages varied from 37 to 80 years, the average age being 53 years. Of the 2 cases in which the diagnosis was made, one was moribund on admission and an operation was not deemed advisable, while the other case refused operation and died 3 days later. Of the 3 undiagnosed cases, 2 had double ulcers. One case, female, age 80 years, had an ulcer on the lesser curvature near the cardiac end of the stomach, and another in the duodenum which had perforated and which was the cause of death. The other case, a male, aged 53 years, had a duodenal ulcer which had perforated and there was also a gastric ulcer on the lesser curvature. In spite of the fact that 2 of 3 of these cases had double ulcers there were not enough symptoms referable to the gastro-intestinal tract to suspect a perforated ulcer.

Group 1B. There were 20 cases that died following operation for acute perforation. They varied in age from 27 to 70 years, the average age being 47 years. Table V gives the type of operation, location of lesion, time that elapsed before operation, and cause of death. It is frequently stated that gastric or corporic ulcers do not perforate, but one case, a male, aged 55 years, was explored for a perforated ulcer which was not found, while at necropsy there was found about 1½ inches from the cardiac opening of the stomach an ulcer which had perforated into the left pleural cavity, there being considerable stomach contents in the pleural cavity. Another case followed in the Gastro-Enterological Clinic was one with a definite gastric ulcer and positive X-ray findings. The patient became symptom free and X-ray examination was negative under medical management and remained so for 7 months, but his symptoms returned when the X-ray films showed positive evidence of a gastric ulcer, so he was admitted to the Medical Wards for treatment. After remaining in the hospital for 10 days he left. The ulcers perforated 5 days later, and at operation there was found on the posterior wall of the stomach a perforation which extended into the lesser peritoneal sac.

Group 2. This group is again divided into A, cases not operated upon; and B, those who were operated upon.

Group 2A. There were 2 cases with a typical history of perforated ulcer, with physical findings

[1]Read before the American Gastro-Enterological Association, May 5, 1930, Atlantic City, New Jersey.

TABLE I.—YEAR OF PERFORATION

Year	Died	Improved	Total
1911	0	1	1
1912	2	0	2
1913	1	2	3
1914	1	3	4
1915	2	1	3
1916	0	2	2
1917	3	3	6
1918	1	4	5
1919	1	3	4
1920	0	3	3
1921	1	2	3
1922	1	4	5
1923	3	6	9
1924	2	6	8
1925	1	7	8
1926	3	5	8
1927	1	8	9
1928	1	8	9
1929	1	12	13
	25	80	105

TABLE II.—MONTH OF PERFORATION

	Cases
January	6
February	9
March	10
April	13
May	9
June	5
July	7
August	6
September	8
October	11
November	13
December	8
	105

TABLE III.—ANALYSIS OF CASES FOR GASTRIC COMPLAINTS

	Cases
Previous history of gastric symptoms	62
No mention made of past gastric symptoms	24
History negative for gastric disturbance	19

confirming the diagnosis, but both patients refused to be operated upon and each left the hospital at his own request. The outcome of these cases is not known.

Group 2B. Thirty-six cases have been operated upon which we have been unable to follow. These cases varied in age from 17 to 59 years, the average age being 35 years. There was one female in this group. Table VI gives the type of operation and location of lesion. There is very little that can be gained from the study of this group, with the exception of one patient, a male, aged 43 years, who at operation had a rupture of 2 pyloric ulcers, both of which were closed by simple suture, plus a gastro-enterostomy. There

TABLE IV.—DEATHS OCCURRING IN PATIENTS NOT OPERATED UPON

	Cases
Diagnosis not made	3
(Two had double ulcers but the duodenal ulcer perforated in each instance. Symptoms did not lead one to suspect an ulcer.)	
Diagnosis made	2
(One case moribund on admission and the other one refused operation.)	
Location of lesion	
Duodenum	3
Duodenum and lesser curvature	2
Cause of death	
General peritonitis in all	5

TABLE V.—DEATHS AFTER OPERATION

	Cases
Type of operation	
Simple closures	15
Horsley pyloroplasties	2
Closure plus gastro-enterostomy	1
Simple excision of ulcer	1
Exploratory laparotomy without finding ulcer	1
Location of lesion	
Duodenum	18
Stomach	2
Hours elapsing before operation	
Six	2
Twelve	3
Twenty-four	11
Forty-eight	1
Seventy-two	2
Ninety-six	1
Cause of death	
General peritonitis	14
Pneumonia	4
Peritonitis and diabetes	1
Pyothorax	1

TABLE VI.—PATIENTS OPERATED UPON BUT NOT FOLLOWED

	Cases
Type of operation	
Simple closure	23
Closure plus gastro-enterostomy	12
Horsley pyloroplasty	1
Location of lesion	
Duodenum	27
Pylorus	6
Stomach	3

was also another case, a male, aged 31 years, with a history of an ulcer for 3 years that perforated on May 29, 1923, and a pyloric ulcer was found at operation. A simple closure was done. Patient was symptom free until November 15, 1925, when he again suffered a perforation and a pyloric ulcer was again found. A simple closure was done. He was symptom free following this but had a gastro-enterostomy done June 1, 1926, since which time he has not been seen.

Group 3. There are now under observation in the Gastro-Enterological Clinic 42 patients who

TABLE VII.—PATIENTS UNDER OBSERVATION SINCE OPERATION

No. Age	Date	History of gastric distress	Location of lesion	Type of operation	Course since operation	Last seen	X-ray	Follow-up	Condition
1 25	2-14-14	1 week	Pyloric	Simple closure	Symptom free until 1-10-29	1-26-29	Refused	Social service visit 9-16-29, moved, address unknown	Satisfactory.
2 24	10-26-19	2 weeks	Duodenal	Simple closure	Symptom free until 10-30-28	2-9-29	Duodenal ulcer 1-22-29	Social service visit 9-23-29, none home, note left. 2-7-30, moved address unknown	Satisfactory.
3 33	12-15-19	4 years	Duodenal	Closure and gastro-enterostomy	Well for 3–4 years, now pain 3–4 hours after meals	6-15-29	Negative 6-20-29	Does not respond to letters. Lives out of state	Fair.
4 50	9-17-20	Several years	Gastric	Closure and gastro-enterostomy	Abdominal pain and constipation	3-8-30	Duodenal ulcer. Gastro-enterostomy stoma normal 1-24-29	Returns regularly	Satisfactory.
5 30	7-15-21	Few weeks	Duodenal	Simple closure	Slight discomfort	2-15-30	Duodenal ulcer 12-9-29	Returns regularly	Satisfactory.
6 32	5-11-22	None	Duodenal	Closure and gastro-enterostomy	No complaints	2-15-30	Negative 7-12-29	Returns regularly	Satisfactory.
7 36	4-12-24	7 months	Duodenal	Horsley pyloroplasty	Abdominal pain	12-21-29	Duodenal ulcer 1-31-30	Returns regularly	Satisfactory.
8 48	10-5-24	7 to 8 years	Duodenal	Horsley pyloroplasty	No complaints, operated upon for acute appendicitis 3-20-26. Duodenum normal at that time	4-21-28	Negative 10-20-27	Social service visit 10-28-29, moved, no address	Satisfactory.
9 35	11-17-24	Few weeks	Duodenal	Simple closure and appendectomy	Well for 3½ years	2-23-29	Duodenal ulcer 10-31-28	Social service visit 9-10-29. Died from pneumococcus meningitis 3-31-29	Fair until he died.
10 36	11-25-24	4 years	Duodenal	Horsley pyloroplasty	Has had abdominal discomfort	8-25-28	Duodenal deformity 8-4-28	Social service visit 12-16-29, moved, no address	Fair.
11 50	1-17-25	3 weeks	Pyloric	Simple closure	No complaints	1-5-29	Duodenal deformity 5-22-28	Social service visit 12-16-29. Neighbor states patient is feeling fine. 3-8-30 Neighbor reports patient well	Satisfactory.
12 37	5-12-25	3 years	Duodenal	Horsley pyloroplasty	Has had recurrent attacks of pain since 3 months following operation	10-19-29	Duodenal irregularity, 4-12-29	Returns at irregular intervals	Fair.
13 ..	6-16-26	None	Duodenal	Simple closure	Free from complaints	12-13-29	Duodenal ulcer 12-16-29	Returns irregularly	Satisfactory.
14 30	1-15-27	10 years	Duodenal	Closure and gastro-enterostomy	Has had pain and vomiting	7-21-28	Refused	Social service 7-9-29, no address	Fair.
15 50	2-26-27	None	Gastric	Excision of ulcer and closure	Had discomfort which came on a few months following operation	3-31-29	Duodenal ulcer 1-28-29	Social service visit 12-16-29, moved, no address	Fair.
16 67	4-14-27	Few weeks	Pyloric	Simple closure	No complaints	-15-30	Negative 2-4-29	Returns regularly	Satisfactory.

TABLE VII.—PATIENTS UNDER OBSERVATION SINCE OPERATION—*Continued*

No. Age	Date	History of gastric distress	Location of lesion	Type of operation	Course since operation	Last seen	X-ray	Follow-up	Condition
17 30	10-18-27	None	Duodenal	Simple closure	Symptom free for 18 months	3-22-30	Negative 1-20-28, 10-1-28. Duodenal ulcer 5-14-29, 10-1-29, 1-31-30	Returns regularly	Satisfactory.
18 17	2-14-28	None	Duodenal	Simple closure	No complaints	12-1-28	Negative 11-19-28	6-8-29 letter from mother, no complaints. Social service visit 10-7-29, no one at home, left note. Also 2-15-30, no one at home	Satisfactory.
19 45	3-8-29	1 year	Duodenal	Horsley pyloroplasty	Slight discomfort at times	3-22-30	Pyloric deformity 3-8-30	Returns regularly	Satisfactory.
20 35	4-20-28	1 month	Duodenal	Simple closure	No complaints	12-28-28	Refused	Social service visit 11-6-29, moved, no address	Satisfactory.
21 41	4-11-28	1 week	Duodenal	Simple closure	No complaints	12-15-28	Refused	Lives out of town, does not respond to letters	Satisfactory.
22 49	5-6-28	2 weeks	Duodenal	Simple closure	Well except for rheumatism	3-22-30	Negative 3-1-30	Returns irregularly	Satisfactory.
23 28	8-20-28	3 months	Duodenal	Simple closure	Has had abdominal pain	5-25-29	Duodenal ulcer 1-24-29	Social service visit 10-7-29, moved, no address	Fair.
24 39	9-7-28	2 years	Pyloric	Simple closure	Has had abdominal pain which began a few months after operation	3-22-30	Duodenal deformity 3-20-30	Returns regularly	Fair.
25 31	10-1-28	Months	Duodenal	Simple closure	Slight discomfort	11-10-28	None	Social service visit 2-15-30, moved, address unknown	Satisfactory.
26 22	4-30-29	None	Duodenal	Closure and gastro-enterostomy	Symptom free when last seen	7-13-29	None	Social service visit 12-9-29. Not known	Satisfactory.
27 22	4-30-29	None	Duodenal	Closure and gastro-enterostomy	No complaints	7-13-29	None	Social service visit 3-10-30. Daughter says he is symptom free since operation	Satisfactory.
28 52	5-5-29	4 weeks	Gastric, two perforations	Simple closure	No complaints	8-17-29	None	2-10-30 working, no complaints	Satisfactory.
29 33	7-8-29	None	Duodenal	Simple closure	No complaints	9-28-29	None	Social service visit 9-12-29. No one at home, left note	Satisfactory.
30 24	7-18-29	None	Duodenal	Simple closure	No complaints	9-19-29	None	Social service visit 3-22-30, no one at home. Note left	Satisfactory.
31 21	7-21-29	Few months	Duodenal	Simple closure	Slight discomfort	3-8-30	Duodena lulcer 1-8-30	Returns regularly	Satisfactory.
32 56	9-2-29	Few weeks	Pyloric	Simple closure	Weak and slight discomfort	3-22-30	Negative 3-7-30	Returns regularly	Satisfactory.

TABLE VIII.—CASES NEEDING A SECOND OPERATION

No. Age	Date	History of gastric distress	Location of lesion	Type of operation	Course since first operation	Last seen	X-ray	Follow-up	Condition
1 54	8-17-23	5 years	Pyloric	Simple closure	Slight discomfort with pyloric obstruction 2-19-29. Gastro-enterostomy 4-5-29	3-1-30	3-30-29 one quarter of motor meal, ulcer first portion duodenum. 10-9-29 negative	Returns regularly	Satisfactory.
2 48	4-8-26	1 year	Duodenal	Simple closure	Finney pyloroplasty for abdominal pain 11-6-28	3-22-30	Duodenal deformity 3-7-30	Returns regularly. No complaints	Satisfactory.
3 45	6-9-26	4 years	Duodenal	Horsley pyloroplasty	Gastro-enterostomy for pyloric obstruction 10-3-27	3-8-30	Gastro-enterostomy stoma normal 3-5-30. No retention or tenderness	Returns regularly. No complaints	Satisfactory.
4 24	2-5-27	None	Pyloric	Simple closure	Gastro-enterostomy for pyloric obstruction 12-19-27	2-4-28	None since second operation	Social service visit 10-21-29, moved, no address	Satisfactory.
5 30	2-24-29	5 year history Medical Wards 10-15-28 to 11-3-28. Clinic 11-3-28	Duodenal	Simple closure	Pain at intervals since operation. Needed second operation 1-10-30 for pain	3-1-30	Duodenal ulcer 1-8-30	Does not return regularly, lives out of town. Operated upon 1-10-30 for pain. Gastro-enterostomy	Fair.

TABLE IX.—CASES PERFORATING WHILE UNDER MEDICAL CARE

No. Age	Date	History of gastric distress	Location of lesion	Type of operation	Course since operation	Last seen	X-ray	Follow-up	Condition
1 32	4-17-28	2 months	Pyloric	Simple closure	Admitted to clinic 5-12-28. Had discomfort 6 weeks after operation	11-24-28	Duodenal ulcer 8-7-28. At Presbyterian Hospital 11-11-29. Ulcer of lesser curvature	Admitted 12-8-28 to another hospital. Perforated on Ward. Pyloric ulcer, simple closure, followed by gastro-enterostomy 15 days later. 11-4-29 old ulcer pain for 3 weeks	Unsatisfactory.
2 28	11-27-28	1 month before medical treatment began 9-28-28	Duodenal	Simple closure	Only occasional abdominal pain	3-1-30	Duodenal deformity 2-17-30	Returns regularly. No complaints	Satisfactory.
3 36	2-24-29	5 year history Medical Wards 10-15-28 to 11-3-28. Clinic 11-3-28	Duodenal	Simple closure	Pain at intervals since operation. Needed second operation 1-10-30 for pain	3-1-30	Duodenal ulcer 1-8-30	Does not return regularly, lives out of town. Operated upon 1-10-30 for pain. Gastro-enterostomy	Fair.
4 49	3-11-29	Several months' history. Began treatment in clinic 5-5-28	Duodenal	Simple closure	Died 12 days later from peritonitis in another hospital	12-1-28	Duodenal ulcer 11-21-28	Admitted to hospital 6-26-28 to 7-16-28, medical management. Followed treatment regularly until 12-1-28	Unsatisfactory.
5 22	4-25-29	6 year history. Admitted Surgical Wards for appendectomy 5-8-28. Duodenal ulcer found. Referred to clinic 5-19-28	Gastric	Simple closure	Slight discomfort	3-8-30	Duodenal deformity 9-16-29	Returns regularly	Fair.
6 54	11-28-29	Under treatment in clinic since 2-24-28. Had complaints for 5 months before starting medical treatment	Gastric	Excision of ulcer and closure	Died 8 days later. Pneumonia	11-23-29	Ulcer lesser curvature pars media 11-11-27. 6-24-28 same. 1-4-29 same. 5-3-29 negative. 10-25-29 small ulcer on posterior wall at junction pars cardia and media	From 3-30-29 to 10-14-29 symptom free. 11-9-29 admitted to hospital for medical care. 11-23-29 returned to clinic improved. Perforated 11-28-29	Fair.

have had acute perforated ulcers of the stomach or duodenum. All of these patients are males and their ages vary from 17 to 67 years, the average age being 39 years.

It was thought best to divide into three groups the cases that have been observed in the Gastro-Enterological Clinic: Group 3A, cases that have had one operation and are under observation; Group 3B, cases that have needed a secondary operation; Group 3C, cases that perforated while under medical management in the clinic. In each case the patient has been referred routinely to the Dental Department for X-rays and extraction when indicated, while those needing nose and throat examination and X-rays of their sinuses have been referred for that. Each case has been sent to the laboratory for a complete blood count, Wassermann, gastric analysis, urinalysis, blood chemistry for urea nitrogen, creatinine, sugar, chlorides, calcium and phosphorus determination. The laboratory findings will not be given in detail at this time.

Group 3A. These cases have been arranged according to year of perforation. It is not intended in this paper to draw conclusions as to what type of operation should be done, but merely to give the operative findings, the type of operation, and the condition of the patient when last seen. There are 32 cases in this group (see Table VII). Use of the terms "satisfactory," "fair," and "unsatisfactory" does not imply a cure or a failure. "Satisfactory" means the patient is able to carry on his daily routine. "Fair" means the patient is able to work but at intervals is incapacitated from the ulcer. "Unsatisfactory" means the patient is incapacitated from work as a result of the condition from which he is suffering. Of the 32 cases in this group, 22 were satisfactory, and 10 fair. There were no unsatisfactory cases although one perforation occurred 15 years ago, two 10 years ago, one 9, another 7, and four 5 years ago.

Group 3B. It was thought advisable to separate the cases that have needed secondary operations and to present the condition of the patient when last seen. There are 5 cases in this series. From Table VIII it will be seen that 4 cases had a simple closure and 1 a pyloroplasty. In 3 cases the second operation was performed for scar tissue obstruction of the pylorus. One case went 5 years and 8 months before the second operation was performed, and the shortest case was 10 months following the first operation. Two cases were operated upon for pain. All of these cases are considered satisfactory since the second operation.

Group 3C. During the past 2 years there have occurred 6 cases of acute perforated ulcers in patients who were under medical care. On January 1, 1930, there were in the Gastro-Enterological Clinic 215 cases of ulcer. Of this number 37 had been operated upon for acute perforations before entering the clinic, and 41 cases had been operated upon for chronic ulcers before coming under our observation. This leaves 139 cases of unoperated upon ulcers that entered the clinic in 1928 and 1929, with 5 cases of acute perforations and one other case that had had one acute perforation and though under constant medical care perforated for the second time following the first operation. From Table IX it can be seen that one case was under treatment for 1 year and 9 months and became symptom free and the X-rays were negative for 7 months when his symptoms returned and he suffered a perforation. Another case had been treated for 1 year and a third for 10 months in the clinic but in both perforation occurred while under our care.

CONCLUSIONS

Patients suffering from a gastric or duodenal ulcer have a chronic recurring disease which may perforate after years of medical management. The fact that a patient has survived an operation for an acute perforation does not mean he is permanently cured, for that is not the case. These patients need constant medical supervision to obtain freedom from symptoms following operation and to diminish the chances of a second perforation.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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MARCH, 1931

THE ELEMENT OF TIME IN GRADED OPERATIONS

IDEALISM in surgery is admirable, stimulating, and productive of advancement. Because of it, technical procedures are evolved and a better understanding of pathological conditions is reached. Idealism aims at extirpation or palliation of the effects of offending neoplasms, inflammatory lesions, or other conditions, in the shortest time compatible with sane and sensible effort. Nevertheless, in every field of surgery, it is amply demonstrated that this idealism, by adherence to which a complete maneuver is accomplished in one stage, must frequently be tempered by mature judgment, the result, often, of unhappy experience, and the more prosaic, uneconomic, and frequently uncomfortable operation in multiple stages must be done.

In surgery of the thyroid gland, prostate gland, stomach, large bowel, and rectum, graded procedures, as a step in the sequence of events, have aimed at eradication or relief of pathological conditions which affect these organs, indubitably have lowered the initial mortality rate, and have enhanced the ultimate satisfactory outcome of operations on these organs. The tendency of every surgeon is to approximate the second stage of a graded maneuver as closely to the initial step as seems feasible, but here is a pitfall into which one is easily led and which, were it avoided as a routine by lengthening the time interval, would add somewhat, perhaps only a tiny fraction, to the reduction of mortality, without influencing the horizon of operability or negativing the radicalness of the procedure at hand.

If one is convinced, in the presence of a bad risk in a case of goiter, that lobectomy is the operation of choice and that operation should be abandoned for the time being after removal of a portion of one lobe, certainly it seems sensible to delay resection of the other lobe for a period of more than 2 or 3 weeks, despite satisfactory improvement under vigorous postoperative treatment with compound solution of iodine, together with loss of some of the offending gland. There is the almost unavoidable temptation to proceed with the second stage, under the circumstances, after this period of time has elapsed, but perhaps a greater margin of safety can be obtained by delaying this stage for 3 months or for even a longer period.

Again, this is particularly true in surgery of the large bowel and rectum, in which, for many anatomical and pathological reasons, one frequently is inclined to employ graded attack on a malignant growth or a complicated inflammatory lesion. Although, unquestionably, in the majority of instances graded procedures can be carried out with confidence, in the interval of from 2 to 3 weeks, probably

greater advantage would accrue to a larger number of patients if a period of from 6 weeks to 2 months, or longer, were permitted to elapse. The ability to judge the patient's resistance and to allocate formidable procedures according to his ability to withstand them, unquestionably is the product of experience, and to err even occasionally in a large series of cases means an increase in the individual mortality.

In operations on the large bowel, the urgent necessity demanding operations in multiple stages for benign or malignant conditions, usually revolves around obstruction, acute or chronic, or concurrent disease affecting the general well-being of the patient. Combating either of these conditions to allow as near a return to normal physiological equilibrium as possible, and to raise the threshold of safety, while extending the opportunity for radical removal of the lesion and gland-bearing tissues in immediate juxtaposition to it, if the lesion is malignant, approaches the most desirable achievement. That this must be accomplished frequently with disregard of the economic situation of the patient, and of the protest of both patient and surgeon against prolonging convalescence is unquestionable, and yet, ultimately to accomplish either cure or prolonged palliation is the aim of all surgical procedures. If, then, by extending the time between stages, one may, without surgical disadvantage, extend the horizon of operability, decrease the immediate operative mortality, and thereby find encouragement to look for improvement in subsequent follow-up statistical data, it seems rational to disregard, from the economic standpoint, the time element in the majority of instances in the search for the optimal time for operation when graded procedures are indicated, and to increase the time interval beyond its accepted minimal limit.

FRED W. RANKIN.

THE EARLY DIAGNOSIS OF ACUTE INTESTINAL OBSTRUCTION

SINCE the dawn of the era of abdominal surgery, a remarkable decrease in the mortality of acute abdominal disasters has occurred. No similar improvement can be boasted in the surgery of intestinal obstruction. Forty years ago internists and surgeons warmly debated whether cases of acute bowel obstruction should be treated conservatively or submitted to immediate operation. In 1888, acute intestinal obstruction was a major subject of discussion at the American Association of Physicians and Surgeons. Nicholas Senn presented the surgical aspects of the problem and Reginald Fitz the medical views; it was the consensus of the meeting that, when after 2 days of medical treatment no improvement had resulted, recourse should be had to operation. Today it is universally conceded that, when the diagnosis is made, the patient should be operated upon. Despite this general acknowledgment the results of operation for acute bowel obstruction are still deplorable.

In 1900, Gibson reviewed 1,000 cases of intestinal obstruction submitted to operation at various hospitals. The mortality was 43.2 per cent. VanBeuren and Smith, in 1925, published a collected report on 1,089 operations performed since 1900 with a mortality of 41.8 per cent. In every statistical study of bowel obstruction, however, it is apparent that the results of early operation compare favorably with those of other acute abdominal disorders.

Three factors contribute largely to late diagnosis in acute intestinal obstruction, viz., absence of local physical findings, the improper appraisal of enemas as a diagnostic criterion, and the irrational administration of morphine.

Unlike other acute abdominal emergencies, obstruction to the continuity of the intestine

presents neither local tenderness nor rigidity suggestive of the existence of a serious lesion within the abdomen. Obstructions presenting strangulation features in which hæmorrhagic infarction of the bowel wall occurs in addition to interruption of the intestinal continuity, like purulent infarction of the appendix, produce signs of peritoneal irritation.

How many operations for acute intestinal obstruction are deferred because the administration of an enema is accompanied by the return of gas and fæces! Every physician knows that the bowel distal to the site of obstruction is anatomically normal. Dogs with complete severance of the ends of the gut expel enemas with the return of gas and fæces; when a small rubber balloon is placed in the loop distal to the obstruction, peristaltic activity of the same character as observed in the normal intestine is obtained and following the subcutaneous administration of eserin or intravenous infusion of hypertonic saline an increase in intestinal activity commensurate with the response of the normal dog's intestine follows. The bowel distal to the point of obstruction is therefore physiologically as well as anatomically normal. Why shouldn't patients with acute bowel obstruction expel gas on the administration of an enema? If the obstruction is partial, gas will be returned as long as enemas are given; in high and complete obstructions, until the gas in the bowel distal to the obstruction has been evacuated. Only in low complete obstructions is early information obtained through rectal irrigations.

An important item in the early recognition of bowel obstruction is the visualization of gas in the small intestine. Whereas gas is normally present throughout the intestinal canal it is visualized on the X-ray film of the adult's abdomen in only the stomach and colon. The intimate admixture of gas and fluid in the small bowel precludes its demonstration. During the first 2 years of life, gas may be regularly identified in the small intestine on the X-ray film, but visible gas in the small intestine of the adult is synonymous with intestinal stasis. Within 4 to 5 hours after the establishment of simple obstruction in the dog, gas may be definitely visualized in the small intestine.

The stethoscope serves to distinguish whether the obstruction is mechanical or inhibitive (paralytic) in character. In the latter a profound stillness obtains or only an occasional faint sound is heard. In obstruction of mechanical origin loud intestinal noises concomitant with the height of the intermittent pain are easily audible. They persist even after pain has been assuaged by morphine. As fluid and air are hurried downward toward the point of obstruction by peristaltic rushes, their progress is suddenly arrested and fluid and air which were churned together in their advance tend to separate as the onward movement is halted. As the air rises to the surface, a sound like drops of water falling in a rain barrel or that occasioned by pouring water out of an inverted bottle with a narrow neck is produced. A metallic tinkle signifies that the bowel is under tension and is imparted only by a distended intestine. Visible peristalsis lends manifest confirmation but unfortunately is usually observed only in subacute and chronic obstructions.

Early in acute bowel obstruction there is no disturbance of the general body economy. The temperature is normal and there is no quickening of the pulse. Elevation of the blood urea, depletion of the chlorides, and alkalosis are observed even in high obstructions only after vomiting has continued for 48 hours and is not a sign to be awaited before the diagnosis is made. Regurgitant vomiting,

meteorism, and absolute constipation, like collapse and euphoria, are but sinister warnings that herald the approach of impending death.

The occurrence of intermittent, crampy, colicky, abdominal pain followed by nausea and vomiting but unattended by tenderness or rigidity suggests bowel obstruction. In no other acute abdominal disorder of a serious nature are local physical findings absent. If gas is visualized in the small intestine on the X-ray film and loud intestinal noises are audible over the abdomen synchronous with the pain, the diagnosis of acute bowel obstruction may be confidently made. A patient suspected of having intestinal obstruction should be under hourly scrutiny and preferably in hospital. The persistence of intermittent pain, despite the return of gas with enemas, is adequate indication for immediate operative intervention. When patients with acute intestinal obstruction come early to operation, results long since obtained in the surgery of other acute abdominal disasters will be regularly recorded.

OWEN H. WANGENSTEEN.

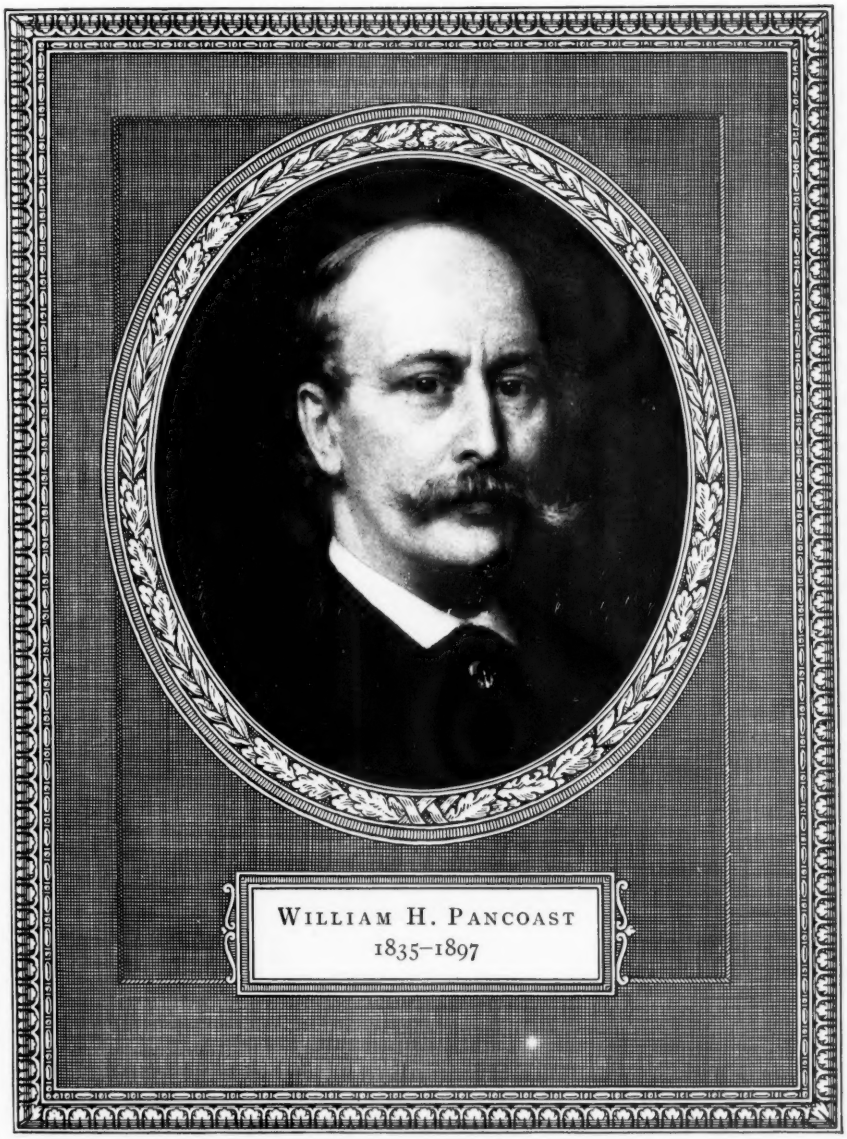
MASTER SURGEONS OF AMERICA

WILLIAM HENRY PANCOAST

WILLIAM HENRY PANCOAST, the son of Joseph and Rebecca Abbott Pancoast, was born in Philadelphia, October 16, 1835. His early education was obtained in the private schools of Philadelphia; he then entered Haverford College and graduated with the degree of A.B., in 1853. Subsequently he received his A.M., from the same institution. He began his medical studies with his father, Joseph Pancoast, and, after taking the regular course at the Jefferson Medical College, received his M.D., in 1856. He then went abroad and spent two and a half years in study in the hospitals of London, Edinburgh, Paris, Vienna, and Berlin. "While in Paris he was a special student with, and often assistant of, the distinguished French surgeon Civiale, who wished him to settle in Paris as his assistant, and offered to take charge of his future." Pancoast, however, declined this offer, and, returning to Philadelphia, commenced a general practice and devoted himself especially to surgery. He soon acquired a reputation as a brilliant diagnostician, a bold and skilful, but conservative, operator.

In 1859, soon after his return to Philadelphia, he was elected visiting surgeon to the Charity Hospital and held the position until his resignation at the end of ten years of service. He was then elected consulting surgeon and a member of the board of trustees. In 1862 he was made demonstrator of anatomy in the Jefferson Medical College and in the same year appointed a member of the Sanitary Commission, doing valuable service during McClellan's disastrous campaign in the swamps about Richmond, Virginia. Returning to Philadelphia, he was stationed at the United States Military Hospital at the corner of Sixth and Master Streets. In 1866 he was elected one of the visiting surgeons to the Philadelphia Hospital.

In 1867 and 1868 during the absence in Europe of his father, Joseph Pancoast, he served as adjunct professor of anatomy, and in 1873 and 1874 he, for a second time, served as adjunct professor of anatomy. In 1874 his father resigned his professorship and he succeeded him as professor of anatomy and at the same time was made clinical professor of surgery. He resigned his professorship in 1886, intending to make a tour of the world, but before he could get away he became interested in the Medico-Chirurgical College, now the post-graduate



WILLIAM H. PANCOAST
1835–1897

school of the University of Pennsylvania Medical School, and was elected professor of general and surgical anatomy and clinical surgery, retaining active connection with this institution the remainder of his life.

Dr. Pancoast was the first president of the Alumni Association of the Medico-Chirurgical College and held the position for many years. He was a member of the College of Physicians, Philadelphia; the Academy of Natural Sciences, Philadelphia; the American Philosophical Society; the various city, county, state, and national medical societies; the Ordre Humanitaire de Mérite Civile in Paris.

Dr. Pancoast was twice married, first to Mary Ann Gertrude Lewis, and second to Charlotte Matilda Robb. By his first wife he had three children, two daughters, and one son, William Howard Pancoast.

In January, 1874, the Siamese Twins, Eng and Chang, died near Mt. Airy, North Carolina, at the age of sixty-three years. Under the auspices of the College of Physicians of Philadelphia, Dr. Pancoast journeyed to Mt. Airy and obtained the bodies on which he performed a necropsy. This showed that the connecting band, situated near the navel, was a few inches long and eight inches in diameter. The band consisted of skin, subcutaneous connective tissue and muscle; portions of the muscles of one crossing those of the other. The interior of the band was occupied by prolongations of the peritoneum which crossed from one side to the other. The livers of the twins were situated close to the connecting band and connected with each other by small blood vessels and a thin layer of liver tissue. It is possible that the twins might have been separated in early childhood by division of the band, but in later life it would probably have been attended with fatal results.

Dr. Pancoast died January 5, 1897. He was greatly beloved by his students and friends. It is said of him, that "His home was the center of hospitality and no medical gathering was quite complete without the presence of Professor Pancoast."

WILLIAM SNOW MILLER.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D., F.A.C.S., OMAHA

THE SURGERY OF BRUNUS OF LONGOBURGO

AS the result of the instruction and publications of Roger, Roland, and the four masters during the twelfth century and the early part of the thirteenth, surgery was well established in Italy and had also gained the ascendency over medicine. That this ascendency would last for a time and these men be followed by a group of outstanding surgeons, some of whom would migrate and carry with them the surgery of Italy to other countries, could easily be foreseen. Data concerning this group of surgeons are given by Guy de Chauliac in the introduction to his *Guidon* or Great Surgery where he cites them individually in chronological order. What he has to say about them and their work may as well be left out here for if it were quoted a doubt might be cast as to whether it is justifiable to write about any of them as Guy was nothing if not caustic in his criticisms. Guy de Chauliac places these men in the following order: Jamerius, Brunus, Theodorich, William of Salicet, Lanfrancus, Arnold of Villa Nova, and Henri de Mondeville, and shows that they bridge the gap between the four masters and himself. Each of the men wrote a work on surgery which has come down to us, though the work of Jamerius has been found only comparatively recently. Each of them took much from their predecessors but also each of them added more or less of his own to surgery even though it might be only in a more clear and concise way of stating his information.

After Jamerius, Brunus of Longoburgo was the earliest of the group. He was born in Longoburgo or Longobucco in Calabria and is sometimes called Brunus of Calabria. He probably received the major part of his education in Salerno though he is also supposed to have studied in Padua and Verona, at that time two of the great medical centers of the world. He certainly spent some time in Padua for in the final paragraph of his *Great Surgery* he says, that he has written his book "in the twelve hundred and fifty second year of the incarnation of the master; among the citizens of Padua, in the place of Saint Paul." His minor surgery he does not date but the opening paragraph leads one to believe that it was writen at the request of one Lazarus, of Padua, and is designed to complete the *Great Surgery* by amplifying the operative portion of the science.

Brunus' surgery appeared first in the *Collectio Chirurgica Veneta* published in 1498 and has appeared in several subsequent collections. The volume from which the illustration is taken is the collection headed by the *Surgery* of Guy de Chauliac and printed by Gregorius de Gregorius in 1513. It is a small folio in which the *Great Surgery* occupies nineteen folios or thirty-eight pages and the small surgery, three and a half folios or seven pages.

In spite of the brevity of Brunus' work it is nevertheless important. He is the first surgical writer to accept the teachings of the Arabian school and endeavor to popularize them by teaching their ideas. He considers Albucasis the greatest of the Arabians in surgery and in this opinion he has been upheld by the majority of writers since his time. He makes no claim to originality as he says in his introduction that his work is "a book collected and excerpted from the teachings of the most glorious Galen, Avicenna, Almansor, Albucasis, and Haly Abbas, and also other skilled men of the ancients." However, he goes beyond their teachings and makes many original suggestions which were of value in the technique of surgery. In the suture of wounds, for example, he advises that the sutures be of silk preferably but if that is not at hand linen may be employed. The sutures should be placed one finger's breadth apart and the lower end of the wound be left open so that if it seems indicated "stuelli" (probably drains) may be inserted so that bloody fluids may be discharged. In larger wounds with deep separation of tissues he lays stress upon the position of the extremity in order that drainage may be free. So he goes on through the surgery. Simple practical points are stressed and always from the standpoint of the surgeon who is to do the actual work; for Brunus believed that surgery was fully as important, if not more important from the standpoint of therapy than medicine, and that an individual who practised it demeaned himself not at all. In this connection one must remember that surgery was at this time becoming recognized as an important branch of medicine, and Brunus was one of the earliest to start the movement which was to lead to the formation of the surgical guilds which were to dominate surgical practice for centuries and wage constant warfare for the recognition of surgery as an independent science and not a trade.

¶ Incipit Cyrurgia magna Bruni Longoburgensis.

Rogasti me iam est diu Andreas vincentine venerabilis amice mi. ꝙ tibi breui & apto ꝛmõe in medicamine cyrurgie libꝝ describerẽ collectũ & excerptũ ex dictis gloriosissimi Bal. Auic. Almansoris Albuca. & Valiab. necnõ & aliorꝝ peritorꝝ veterũ. ¶ Et ego qdẽ ꝫ ꝑ eminẽtiã negocioꝝ tibi lõganimita' é bucusq; ꝓsiterim tñ volũtẽ sic nouit scrutatoꝛ oium secretorꝝ tuũ defraudãdi desidertũ nõ ꝙsui: imo illud in te cõplere auide peroptaui. ¶ Quapꝛopter nunc munifice dextere saluatoꝛis fulcra gio imminẽte iurta posse meũ tue petitiõi optato aio to taliter acquiesco. ¶ Suscipiat igit tue dilectiõis sinceritas munusculũ: ꝓo cuius ꝓplemcto coopante dño labore assumere nõ vitaui: cũ mihi tuis satisfacere ꝓcib⁹ non sit durum: sed gratũ nõ asperum sed amenum.

¶ Primo sciẽdũ est ꝙ tractat⁹ istⁱ libꝝ diuidit in duas ptes. In quaꝝ ꝑma capla collocaui: de ḡbus ꝑme pti vt ginti attribui: & sit scõe vigintⁱ: vt ꝑ certũ ipsoꝝ numeꝝ: qõ ẋrĩ in eo facilius possit inueniri. ¶ Est aũt vere liber cõpositus ꝑm mẽsurã quã ꝙsulsti. s. ꝑm descriptiones q̃ inueniunt in libris veterũ: quoꝝ rememoratio iã ꝓfessit. Sed anteq̃ ad tractatũ ꝑpꝛiũ fiat descensus: vt ciuꝰ accessus facilius bẽat q̃dam sũt ꝓnotãda. s. qd sit cyrurgia vñ dicat. cuiusmodi bẽant eẽ opatones eius. q̃ sit eoꝝ inter̃tio: necnõ ꝓncipalꝛ in quot spẽs diuidat. ¶ Est ḡ cyrurgia vt cõiter dr manualis opatio in corꝑe alalio ad sanitatem tẽdẽs: vel vt aptius declaret. ¶ Cyrurgia ẽ postremum instrm medicine. Instrã qdẽ medicine sunt tria: quibus mediãtibus morboꝝ causio valet medicus summa diligẽtia subuenire. ¶ Et illa sunt sic dicta potio & cyrurgia. ¶ Dicta est primũ instrm: & est melius regimẽ sic̃ testat Bal. in cõmẽto regiminis acutoꝝ dicẽs: ꝙ si possumus boiem curare ꝑ dietã nõ curemus eũ cũ aliq̃ potione. & idẽ Damascenus in suis aforismis. si poteris boiez curare ꝑ dietã ꝑsperã inuenies ꝙ regimen exigit ꝫ cãm: & facit digõnẽ. ¶ Scõm regimẽ est potio: & de ꝫ ẽt dicit Bal. ꝙ si cũ ea possumus remouere infirmitatẽ nõ accedamus ad cyrurgiã. ¶ Est ḡ 3ᵐ instrm sic̃ dcm est cyrurgia cuius bñficio remouef qõ ꝑ ista duo regimina nõ ꝓt remoueri. ¶ Dicit aũt cyrurgia a cyros grece q̃s est manus & agia qõ ẽ actio inde cyrurgia. i. q̃s manualis opõ eoꝝ ꝙ eius ꝑfectio & integritas in actiõe siue opatiõe manuum exĩstit. ¶ Opꝛ aũt opatoꝛes cyrurgie: vt dicit Valiab. in cõmẽto ꝑmo loca freq̃ntare in ḡbus assueti sunt periti cyrurgicoꝝ & eoꝝ opões diu ac diligẽter inspicere nec sint temerarij nec audaces: ꝫ sint suauissimi: atq; cautissimi in opando maxime in locis timoꝛosis vt in cerebro si sint vinolẽti: sic ãt bibãt vinũ vt sensui nõ dñet: quia q̃ sunt necia ad arté nõ ꝑtin in libris cõprehendi ad plenũ: iõ sint vir ingenioſi valde: etenim nãle cõmẽdat ingenium in medico & maxime a Damasceno. vbi dicit ingeniũ nãle medici adiuuat artẽ & nãm regẽtẽ ꝺrio ꝺo ꝛiũ. ¶ Sint ẽt viri litterati: aut ab eo q nouit ſras ad minus artẽ adiscãt. vir. n. aliquẽ absq; ſris bãc artẽ cõprehẽdere puto: ꝫ tpe ꝑtⁱ nedũ idiote: immo ꝙ indecẽtⁱ⁹ & bozbrilⁱ⁹ iudicat viles semine & ſlamptuose artẽ bãc vsurpauerũt: & abutunt ea q̃ ꝫ curãt. vt refert Ãlmãsoꝛ nec artẽ nec ingeniũ bñt. ¶ Et refert ꝙ illi q bãc artem exercẽt ꝑ maiorẽ ꝑte sunt idiote rustici & stolidi: ꝓpter cãz sue stoliditatis egritudines pessime in boibus gñantur q̃bus fortasse egri interficiunt cũ nõ sapiẽter nec sub certa rõne sed casualiter operãt & cãs & noia infirmitatũ ignorãt asserũt se sanare penitus nõ agnoscunt. ¶ Intẽtio cyrurgicoꝝ est opari circa tria. s. circa ꝓiũctionẽ solutoꝝ & separationẽ ꝓiũctoꝝ ꝑter nãm & extirpationem superflui.

¶ Sũt aũt cyrurgie spẽs due vt sic̃ testat⁹ est Jaãnitius cũ dicit. cyrurgia duplex est. aut in carne aut in osse: & ſm ẑrietatẽ subiectoꝝ: nã alia fit i mẽbris mollib⁹ vt in carne neruis in venis & sitib⁹. Alia fit in mẽbris mollib⁹ vt in ossib⁹ & sitib⁹: q̃ sic̃ differũt in ẑrietate q̃litatũ. s. duritie & mollitie. sic ẽt in oi opõne cyrurgie. ꝫ q̃ fit in mẽbris mollib⁹ subdiuidif tripliciter fit in carne tñ: & illa scarificatio aut incisio vel suitio aut incẽsio nũcupat: aut fit in venis nõ pulsatilib⁹: & oĩ flõmia vel in pulsatilib⁹ & dr sectio: aut fit i neruis ꝫ latũ & icisio noiat: aut ꝫ lõgũ: & dr scissura vel pũctura ꝫ in dyafragmate vt pãniculo dicat ruptura. q̃ vo fit in mẽbris duris: dupler ẽ: qm̃ aut fit in ossib⁹ ruptis & dr ꝓsolidatio fractoꝝ: aut fit i ossib⁹ dislocatꝫ a suo ꝓpꝛio scemate: & appellat ꝓiũctio dissiciuoꝝ de qb⁹ oib⁹ tractãdũ ẽ: ꝑterq̃ de scarificatiõe & flõmia: q̃ ꝫ cyrurgie spẽs bẽant: tñ de eis ꝑmi docuerũt auctoꝛes ac ipsoꝝ opõnẽ noluerũt medici ꝙ indecẽtiaꝫ exercere: sed illas barberioꝝ in manibus reliquerunt.

¶ Incipiunt capitula libri primi.

Capitulum

ꝑmum de diuisione & gñalibus causis solonio continuitatis.

2ᵐ De cõmuni dispõne solutionis continuitatis ꝫ dr uersitatem membꝛoꝝ.

3ᵐ De ſma & aggregatiõe curatiõis vulnerũ & vlcer.

4ᵐ De reductiõe intestinoꝝ & ẑrbi & de vulnere q̃s accidit intestino: necnõ de regimine oium aliorꝝ vulnerũ ad interioꝛa corꝑis penetrantium.

5ᵐ De summa curatiõis vulnerꝝ neruoꝝ in vti.

6ᵐ De iudiciis mortis vel periculis in ḡbus cõmunicant vulnera quoꝝdam membꝛoꝝ.

7ᵐ De vulneribus que fiunt ex contusione.

8ᵐ Quare vulnera mozank ad curandũ: & de cautelis curationis ipsoꝝ.

9ᵐ De diffinitõe & nã medicinaꝝ faciẽtiũ nasci puꝝ & ipsam collectionem & cõpõne ipsarum.

10ᵐ De diffinitiõe & nã medicinaꝝ faciẽtiũ nasci carneꝫ in vulneribꝰ & vlceribus & incarnatiuaꝝ & ꝓsolidatiõmecnõ de ꝓsideratiõe eoꝝ q̃ attẽdẽda sunt circa naturalẽ cõpõne mẽbꝝ vulnerati et totⁱ⁹ corꝑis atq; vulneris et vlceris et de mõ administratiõis et collectiõis et cõpõnis ipsarum.

11ᵐ De cõi disputatiõe curationis vulnerũ et vlcerꝝ.

12ᵐ De fluxu sanguinis ex vulnere.

13ᵐ De abstractione teli sagitte & astellarum.

14ᵐ De summa et vti curatione vlcerum.

15ᵐ De summa et vti curatiõe fistularum.

16ᵐ De summa et vti curatione cancri.

17ᵐ De fractura cranei.

18ᵐ De vti curatiõe ossiũ et extẽsiõe et rectificatiõe.

19ᵐ De particulari curatione fracture ossium ꝓtinens rubricas septem.

℞ᶜᵃ I De fractura ossium mandibularum.

II De fractura furcule, pectoꝛis.

III De fractura costarum.

IIII De fractura adiutoꝛij.

V De fractura brachij.

VI De fractura coxarum.

VII De fractura cruris.

20ᵐ De dislocatione iuncturaꝝ ꝓtinẽs rubricas decẽ.

℞ᶜᵃ I De dislocatione in vniuersali.

II De dislocatione mandibularum.

III De dislocatione humeri.

IIII De dislocatione cubiti.

V De dislocatione iũcture manus.

VI De dislocatione digitoꝝ manus.

VII De dislocatione ꝑondilium.

VIII De dislocatione anche.

IX De dislocatione genu.

X De dislocatione calcanei.

REVIEWS OF NEW BOOKS

THE book *Diseases of the Urinary Tract in Children*[1] written in monographic form is based on rather extensive experience mostly in the wards of Mt. Sinai Hospital, New York. It is an excellent example of hospital co-operation between the departments of pediatrics and urology and shows what the fruits of this type of co-operation may be.

General symptoms and the various methods of examination are briefly but clearly presented. The chapters on enuresis, infections of the urinary tract, abscess and carbuncle of the kidney, foreign bodies in the urinary tract, congenital anomalies of the upper urinary tract, urinary lithiasis, chronic renal tuberculosis, injuries, and tumors leave nothing to be desired in the matter of thoroughness.

Attention should be called to the chapter on pyelitis because not only is it well written but it presents, in a concise form, the views as we know them today. Malignant tumors of the kidneys, always an interesting subject, are discussed from the various angles which make for enlightenment, and the different theories of the origin of kidney tumors in children are not neglected.

The pediatrician especially and also the general practitioner should be interested in the chapters dealing with disturbances in the outflow of urine from the bladder, obstruction at the neck of the bladder, and in the urethra, and diverticulum of the bladder—subjects which hitherto have received but scant attention in the literature.

It goes without saying that this book, dealing as it does with diagnosis, pathology, and treatment, should prove of exceeding value to the general practitioner who, as a rule, sees these cases first, to the pediatrician who has not always been fully trained in urology, and to the urologist whose work has been wholly or almost wholly confined to the adult.

The book is profusely illustrated and each chapter contains an excellent bibliography.

H. L. KRETSCHMER.

A COLLECTION of the well known papers of Drs. C. H. Lawrence and A. W. Rowe that have appeared in the course of the past ten years is found in the book entitled *Collected Publications from the Robert Dawson Evans Memorial for Clinical Research and Preventative Medicine*.[2] The method of study is unique, being statistical and complex. The section on the thyroid is typical. It consists of tabulated data of observations of physical measurements, vital capacity, urine studies, blood chemistry, blood morphology, respiratory metabolism, and galactose tolerance; a clinical section reporting 100 cases of thyroid failure of which the data are also tabulated; and a number of groups of case reports. This volume will serve as a useful reference work for those studying endocrine disorders.

PAUL STARR.

CROSSEN'S *Diseases of Women*[3] is a standardized text familiar to all. The revised seventh edition includes the newer methods of diagnosis and treatment of gynecological conditions presented in the past several years.

The text, which comprises over 1,000 pages and approximately 950 illustrations, is interesting and easy reading; the illustrations are instructive and exceptionally well done.

This book is an excellent text for the student of gynecology and an ideal reference for the practitioner.

E. A. EDWARDS.

IN his *Urologie Pratique*[4] Dr. P. Bazy has put into 467 pages the urological facts which might be of use to the general practitioner; he has done this without burdening the book with long dissertations.

In general, the author believes that urinary antiseptics have such short contact that their value is questioned; he uses boric solution for lavage and salol internally. It is stated that electrolysis in the treatment of urethral strictures has been given a fair trial and found to have no value. Dr. Bazy also believes that Maisoneuve's urethrotome cuts and damages too much of the healthy urethra; so he has devised a urethrotome to avoid this. It is interesting to note that this writer believes all gonorrhœal urethritis becomes posterior by the fourth day of the disease. In his discussion of urinary tuberculosis, he states that the origin of the disease is always in the kidney.

In agreement with American teaching, Dr. Bazy writes that in bilateral obstructive anuria, the healthiest kidney should be operated upon first. Attention is called to the fact that a ureter often has a larger caliber than the urethra—this is to be kept in mind when one is using the watchful waiting policy in the treatment of ureteral stones.

Dr. Bazy emphasizes over and over that much acute urinary retention can be ascribed to cystitis rather than to the mechanical obstruction of a prostate or stricture; he argues that retention from a stricture is due to a spasm of the bladder rather than to mechanical obstruction.

The section on hæmaturia is very interesting and instructive; his advice to examine cystoscopically a patient who has hæmaturia when he is not bleeding will not be agreed to by many American workers.

HARRY CULVER.

[1] DISEASES OF THE URINARY TRACT IN CHILDREN. By Edwin Beer, M.D., and Abraham Hyman, M.D. New York: Paul B. Hoeber, Inc., 1930.

[2] COLLECTED PUBLICATIONS FROM THE ROBERT DAWSON EVANS MEMORIAL FOR CLINICAL RESEARCH AND PREVENTATIVE MEDICINE. No. 1. ENDOCRINE STUDIES. Boston: F. J. Barnard & Company, Inc., 1929.

[3] DISEASES OF WOMEN. By Harry Sturgeon Crossen, M.D., F.A.C.S., and Robert James Crossen, M.D. 7th ed. rev. St. Louis: The C. V. Mosby Company, 1930.

[4] UROLOGIE PRATIQUE. By Dr. P. Bazy. Paris: Gauthier-Villars et Cie, 1930.

IN his book on *Nursing in Emergencies*,[1] Berman's definition of first aid treatment is somewhat confusing. He divides emergencies into two classes: surgical and medical. Under medical cases he includes "those evolved without trauma or external force." He then lists twelve conditions producing unconsciousness and instructs the nurse in recognizing and differentiating these conditions and in treating them. He shows "how dependent rational treatment is upon an accurate diagnosis." But that this "to say the least requires the skill and knowledge of a competent physician."

I think it is safe to say that no institutional nurse would be permitted to give hypodermic injections of morphine or digafolin, or to use a stomach pump without an order from a doctor or without previous agreement as to her authority to handle such situations. Usually organizations employing first aid workers have physicians in charge who have their own ideas about the nurses' equipment and dictate accordingly. Such a nurse is told what her duties consist of. It is probable that a nurse might get herself into serious difficulty were she to give digafolin upon her own diagnosis without previous instructions from a physician. Any advice which Dr. Berman may give in his book about what the physician should do seems beside the point. For a nurse to know when these medications and treatments are indicated is important. For her to understand and accurately appreciate a situation may save life. Telephones are not rare and orders may be received and carried out in this way if the nurse is able to explain intelligently to the physician.

The list of poisons and their antidotes, which Dr. Berman gives in chapter three, is strictly first aid care and for nurses who meet with such situations more or less regularly it is wise of them always to carry with them such a list. Any nurse should be familiar with the more common forms of poisoning such as alcohol, morphine, bichloride, arsenic, turpentine.

A large part of the book gives such information as nurses commonly get who are graduates of class A nursing schools. Such information is given in courses on surgical nursing, obstetrics, clinic work, and public health.

There is much of value in Dr. Berman's book, but the information is so mixed with medical and surgical treatments and nursing care of surgical cases that the pertinent facts concerned with emergency work, as I understand it, lose significance in the mass of other detail. E. B. J.

[1] NURSING IN EMERGENCIES. By Jacob K. Berman, A.B., M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1929.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

INTESTINAL TOXEMIA (AUTOINTOXICATION) BIOLOGICALLY CONSIDERED. By Anthony Bassler, M.D., F.A.C.P. Philadelphia: F. A. Davis Company, 1930.

LA NOUVELLE MATERNITÉ BAUDELOCQUE; CLINIQUE OBSTÉTRICALE DE LA FACULTÉ DE MÉDECINE DE L'UNIVERSITÉ DE PARIS. Directed by Prof. Alexandre Couvelaire. Paris: Masson et Cie, 1930.

PHYSICAL DIAGNOSIS. By Warren P. Elmer, B.S., M.D. and W. D. Rose, M.D. St. Louis: The C. V. Mosby Company, 1930.

MEDICAL JURISPRUDENCE; A STATEMENT OF THE LAW OF FORENSIC MEDICINE. By Elmer D. Brothers, B.S., LL.B. 3d ed. St. Louis: The C. V. Mosby Company, 1930.

OPERATIVE GYNECOLOGY. By Harry Sturgeon Crossen, M.D., F.A.C.S., and Robert James Crossen, M.D. 4th ed. St. Louis: The C. V. Mosby Company, 1930.

TRANSACTIONS OF THE AMERICAN PROCTOLOGIC SOCIETY; THIRTY-FIRST ANNUAL SESSION. Held at Hotel Statler, Buffalo, New York, June 22d, 23d, and 24th, 1930. Reading, Pennsylvania: Reading Eagle Press.

GLASGOW ROYAL MATERNITY AND WOMEN'S HOSPITAL MEDICAL REPORT FOR THE YEAR 1929. Prepared by J. N. Cruickshank, M.D., F.R.F.P.S. (Glas.), M.R.C.P. (Lond.). Glasgow: Aird & Coghill, Ltd., 1930.

WILLIAM STEWART HALSTED; SURGEON. By W. G. MacCallum. Introduction by Dr. W. H. Welch. Baltimore: The Johns Hopkins Press. London: Oxford University Press, 1930.

TREATMENT OF EPILEPSY. By Fritz B. Talbot, M.D. New York: The Macmillan Company, 1930.

CHRONIC ARTHRITIS AND RHEUMATOID AFFECTIONS; WITH RECOVERY RECORD. By Bernard Langdon Wyatt, M.D., F.A.C.P. With the Collaboration of Louis I. Dublin, Ph.D.; and Foreword by Dr. J. Van Breemen. New York: William Wood and Company, 1930.

METHODS AND PROBLEMS OF MEDICAL EDUCATION (EIGHTEENTH SERIES). New York: The Rockefeller Foundation, 1930.

PIERSOL'S HUMAN ANATOMY; INCLUDING STRUCTURE AND DEVELOPMENT AND PRACTICAL CONSIDERATIONS. 9th rev. ed. Under the Supervision of G. Carl Huber, M.D., Sc.D. Philadelphia, Montreal, London: J. B. Lippincott Company, 1930.

PRACTICE OF SURGERY. Edited by Dean Lewis, M.D., Sc.D. Vol. iii. Bones and Joints (cont'd), Muscles, Tendons, Nerves, Brachial Palsy, Sympathetic Nerves, Lymphatics, Amputations. Vol. iv. Eye, Ear, Nose; Mouth, Jaw; Salivary Glands; Pharynx, Larynx, Trachea; Thorax, Œsophagus; Mediastinum; Heart, Pericardium. Vol. v. Pulmonary Tuberculosis, Pulmonary Suppuration, Massive Collapse of Lung, Tumors of Chest, Mammary Glands, Diaphragm, Plastic Surgery, Hand. Vol. vii. Pancreas; Liver, Bile Passages; Appendicitis; Intestinal Tract; Rectum and Anus; Intestinal Obstruction; Peritoneum; Hernia. Hagerstown, Maryland: W. F. Prior Company, Inc., 1930.

CINCHONA TERCENTENARY CELEBRATION AND EXHIBITION; AT THE WELLCOME HISTORICAL MEDICAL MUSEUM. Henry S. Wellcome, LL.D., F.S.A., Director, L. W. G. Malcolm, M.Sc. (Cantab.), F.R.S.E. London: The Wellcome Foundation Ltd., 1930.